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SEMELE

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THE GENUS *SEMELE* IN THE WESTERN ATLANTIC

(Semelidae; Bivalvia)

BY

KENNETH J. BOSS

ABSTRACT

The western Atlantic species of the molluscan lamellibranch genus *Semele* are reviewed. Six species are recognized: *Semele proficua*, *S. modesta*, *S. purpurascens*, *S. bellestriata*, *S. casali*, and *S. nucoides*.

Aspects of the zoogeography and the Tertiary history of these species are presented, and a general discussion of the shell characters and of the anatomical attributes of the genus is included.

Semele is subdivided into the nominate subgenus with five species and the subgenus, *Semelina*, with a single species. A description and discussion of the superspecific taxa are given.

A synonymy of each species is provided along with a discussion of the important aspects of nomenclatural history. Biological and paleontological data are included, and the bathymetric and geographic range of each species is established on the bases of examination of museum specimens and upon reference to literature.

INTRODUCTION

Semele is the largest genus in the tellinacean bivalve family Semelidae and is widely distributed in the warm temperate and tropical waters of the world. The genus is con-

spicuously rich in number of species in the Eastern Pacific; Keen (1958) noted 28 and Olsson (1961) listed 21 species. In the Atlantic and Indo-Pacific regions, the genus is not as highly developed. Certain other semelid genera, *Iacra*, *Theora*, and *Montrouzieria*, for example, are limited to the Indo-Pacific region whereas still others, *Cumingia*, *Abra*, and *Leptomya*, are of wider distribution and not limited to a single oceanic basin. The genus *Scrobicularia* is similar to *Semele* in many respects but differs in its lack of right lateral dentition and in having smooth and homorhabdic gills. Representatives of the Scrobicularidae were at one time included in the Semelidae (Lamy, 1914) but the families have been separated (Newell, 1965).

The family Semelidae is a young one in the geological record and makes its appearance in the Eocene (Zittel, 1900). Numerous representatives, particularly of the genus *Abra*, have been recorded in the Eocene of the Paris Basin (Cossmann, 1886). Harris (1919) and Aldrich (1921) have described species of *Semele* in North American Eocene deposits. Stoliczka (1871) stated that there are no known species of the family from Mesozoic deposits, although he discussed

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some fossils of Mesozoic Age incorrectly referred to the semelids, *Amphidesma*, *Lavignon*, and *Abra*.

During the Tertiary the genus had numerous representatives in the western Atlantic and Antillean fauna. Gardner (1928) listed 11 species in the Alum Bluff Formation alone and stated that some 30 species occurred in eastern North American formations. Some of the Tertiary species were conspicuously larger than any of the living species, and as Olsson and Harbison (1953) have pointed out, several relatives of these larger species persist today in the fauna along the Pacific coast of Panama and northern South America. Only six species of *Semele* are in the Recent fauna of the western Atlantic and two of these are of limited southern occurrence. The majority of the species have relatively well-documented fossil histories and can be traced back into the upper Miocene.

The widely distributed species of the Tertiary were the stem elements from which the modern fauna arose. The factors of geographic isolation and consequent allopatric speciation are evident when the closest relatives of the western Atlantic species are considered. Of the six species, four have so-called analogous elements in the eastern Pacific. Table 1 lists the Atlantic species, their ranges, and the Pacific species with which they are related. The four widely distributed Atlantic species with occurrences in the Caribbean form species-pairs; the species *modesta* and *casali*, which have more restricted ranges, probably arose from autoch-

thonous Atlantic elements. Most of the Atlantic species are sympatric with each other, a situation which indicates that the species are "old" in a geological sense, an indication that is corroborated in the fossil record.

ACKNOWLEDGMENTS

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ABBREVIATIONS

ANSP — Academy of Natural Sciences of Philadelphia
BMNH — British Museum (Natural History)
MCZ — Museum of Comparative Zoology
UMML — University of Miami, Marine Laboratory
USNM — United States National Museum

SHELL MORPHOLOGY

The gross morphology of the shell of *Semele* is illustrated in Plate 1. The muscular impressions on the internal surface of the valves reflect some of the anatomical characteristics of the animal. The shape of the pallial sinus and its position in relation to the adductor muscle scars have diagnostic value for the identification of some of the

Table 1. Western Atlantic species of *Semele*, their ranges and their eastern Pacific analogs

Atlantic species	Range	Eastern Pacific analog
<i>proficua</i>	North Carolina to Argentina	<i>lenticulare</i>
<i>purpurascens</i>	North Carolina to Uruguay	<i>sparsilineata</i>
<i>bellestriata</i>	North Carolina to Brazil	<i>pacifica</i>
<i>nuculoides</i>	North Carolina to Brazil	<i>subquadrata</i>
<i>modesta</i>	Brazil to Gulf of Guinea	none
<i>casali</i>	Brazil to Argentina	none

species. On the other hand, the scars of the cruciform muscles are obscure or poorly impressed and, because of their relative irregularity or placement, are of inconsequential diagnostic value.

The microscopic structure of the shell of representatives of the Semelidae was studied by Boggild (1930) and Oberling (1964);

cardinal tooth and of a thin laminate posterior cardinal tooth. Anterior and posterior lateral teeth are present and situated some distance from the umbo; they are weaker than the lateral teeth of the right valve and fit into sockets above the right lateral teeth. In the right valve the cardinal complex consists of a posterior sub-bilobate cardinal tooth

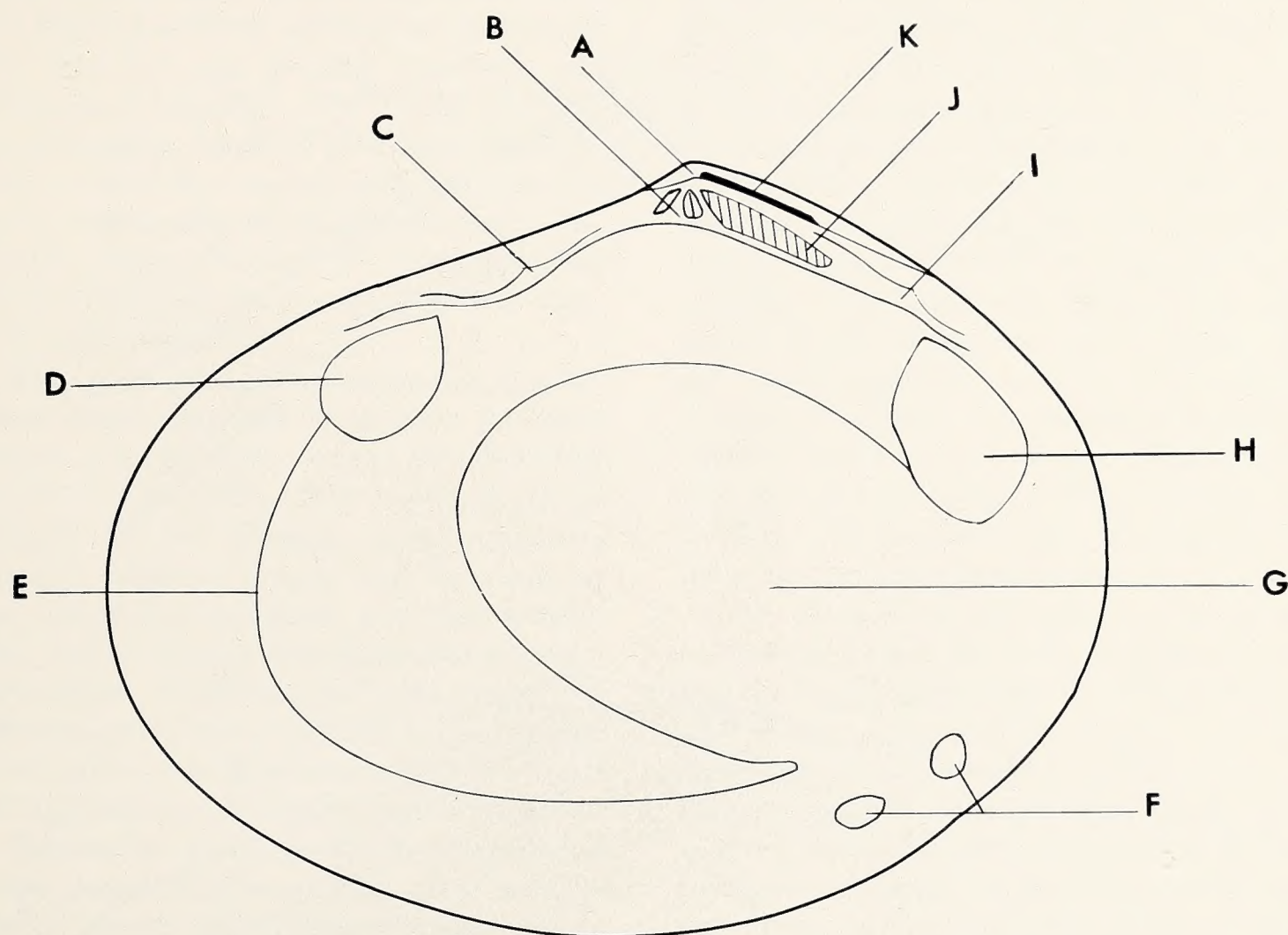


Plate 1. Diagram of an internal view of the right valve of *Semele* to show the morphological features. A — umbo; B — cardinal complex; C — anterior lateral tooth; D — anterior adductor muscle scar; E — pallial line; F — cruciform muscle scars; G — pallial sinus; H — posterior adductor muscle scar; I — posterior lateral tooth; J — internal element of the ligament or resilium; K — external element of the ligament.

the latter introduced a new nomenclature for the specific shell layers. In *Semele* the outer layer or ectostracum is prismatic, the middle layer or mesostracum is cross-lamellar, and the inner layer or endostracum is complex.

The dentition of *Semele* consists of differentiated lateral and cardinal elements (Plate 2). In the left valve the cardinal complex consists of a sub-bilobed or bifid anterior

of varying strength and of a thin to subdeltoid laminate anterior cardinal tooth, which is incorporated or coalesced into the floor of the lunule. The lateral dentition, consisting of anterior and posterior teeth, is socketed above, relatively well developed, and up-curved. In many specimens the exact nature of the cardinal dentition is obscured by the breakage and loss of the teeth. The positions

of the right lateral teeth relative to the cardinal dentition may be important as specific identifying characteristics.

The ligament of *Semele* is opisthodontic and consists of a thin, elongate external portion and of a well-developed internal element or resilium which is supported by a calcareous chondrophore. The fine structure of the ligament of the Semelidae was discussed by

sess a different sculptural pattern and it is this character that is fundamentally diagnostic.

ANATOMICAL NOTES

The following résumé of the anatomical characteristics of *Semele* is based largely on a dissection of *Semele purpurascens*. The purpose of this discussion is to review the general gross anatomical features of *Semele*;

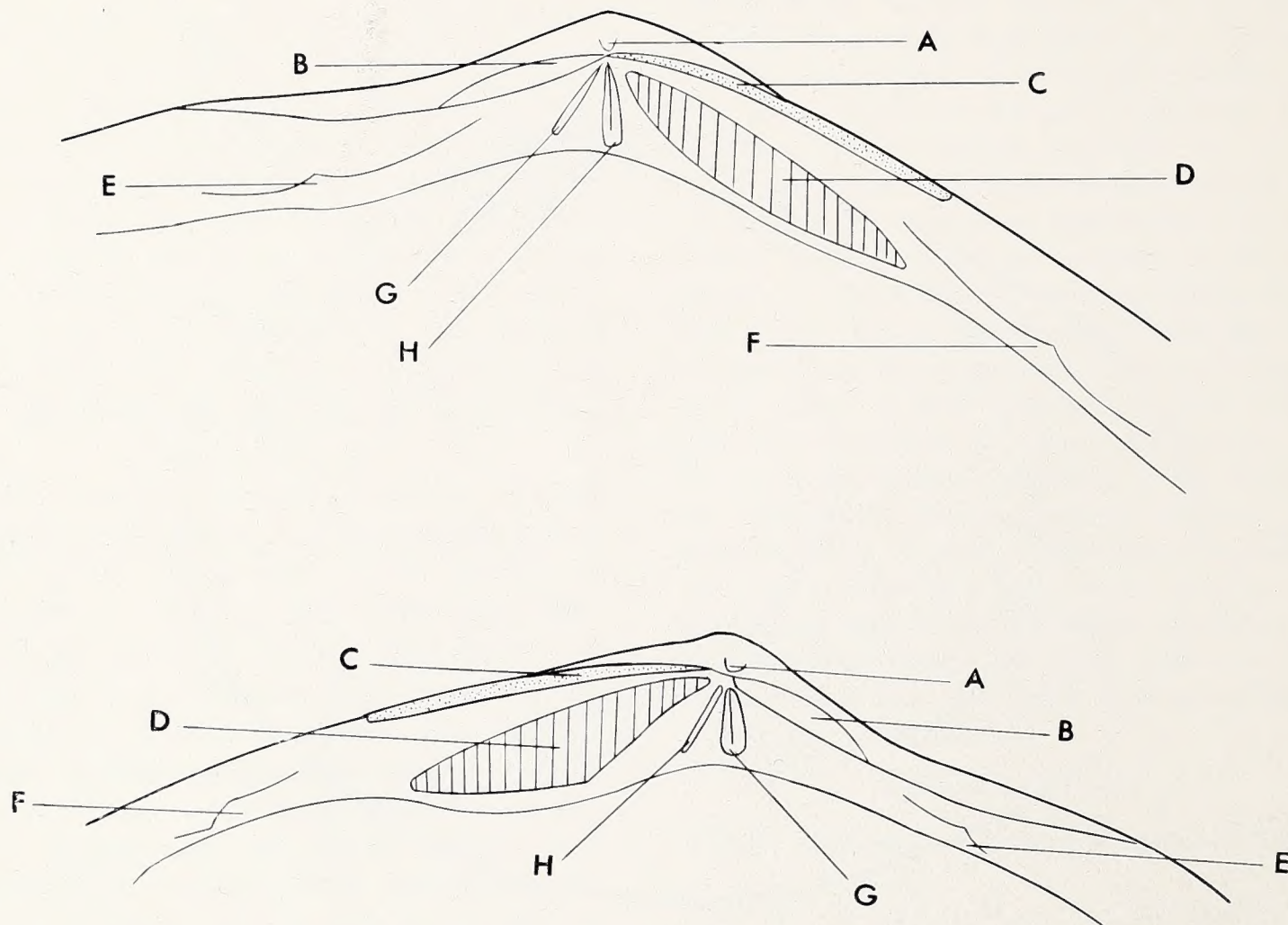


Plate 2. Diagram of the hinge structure of *Semele*. Upper figure, right valve; lower figure, left valve. A—umbo; B—lunule; C—external portion of the ligament; D—internal element of the ligament or resilium; E—anterior lateral tooth; F—posterior lateral tooth; G—anterior cardinal tooth; H—posterior cardinal tooth.

Trueman (1953) who worked on *Scrobicularia plana* and *Abra alba*.

The most important species-specific conchological trait is the exact nature of the external sculpture. No doubt the sculpture of the valves has adaptive significance, although we are unable to explain the appearance and evolution of peculiar types of sculpture. All of the species treated herein pos-

sess a different sculptural pattern and it is this character that is fundamentally diagnostic. Plate 3 illustrates the general anatomy.

The mantle is thin and transparent over most of its surface. It is united dorsally and fused posteroventrally at the cruciform muscle and anteriorly at the anterior adduc-

tor muscle. Dorsally the mantle is modified in the region subtending the resilium. The pedal gape is large and extends ventrally from the anterior adductor to the cruciform muscle. The mantle is thickened ventrally where its edges are differentiated into outer, middle, and inner lobes. Along the margins short tentacles are developed on the middle lobe. Posteriorly, separate ventral incurrent and dorsal excurrent siphons are developed. The foot is large, pointed anteriorly, and compressed laterally. The byssal gland is vestigial and no byssus is developed (Barrois, 1885). Both the siphons and the foot are active and capable of considerable extension. Yonge (1949) discussed the intrinsic musculature of the siphons in regard to their flexibility and extensibility.

The general muscular system of *Scrobicularia plana* and *Semele solidum* has been described by Graham (1934) and Schröder (1916), respectively. The muscular system consists of the elongate and semilunate anterior adductor muscle and the more or less subcircular posterior adductor muscle. The well-developed extrinsic pedal musculature consists of bilateral pairs of anterior and posterior pedal retractors and of an anterior pedal protractor. The anterior pedal retractor is attached to the shell immediately dorsal to the anterior adductor muscle along the anterior dorsal margin of the valve; this retractor courses posteroventrally and inserts deeply into the foot. The posterior pedal retractor attaches to the shell along the posterior dorsal margin just dorsal to the posterior adductor muscle. It courses anteroventrally through the kidney and inserts superficially into the foot. The pedal protractor attaches to the shell within the circum-muscular tissue on the posterior ventral surface of the anterior adductor muscle. Contrary to Schröder's (1916) statement, an elevator pedal muscle does not appear to be present. The siphonal muscles splay out into the mantle laterally; they leave a scar on the shell which defines the pallial sinus. Two

heads of this muscle are attached to the bases of the incurrent and excurrent siphons, respectively. The cruciform muscle with its slit-like specialized sensory pit is found posteriorly, where the ventral portion of the siphonal retractor attaches to the muscular lobe of the mantle.

The labial palps are rather elongate, sub-triangular, plicate on their entad surfaces, and much smaller than the ctenidia; they are capable of considerable contraction.

The gill is similar to that of *Tellina*; it consists of an inner ventral demibranch which is complete in having both inner and outer lamellae. The outer demibranch is smaller, upturned, and reduced to only the inner lamella. The combined demibranchs are united distally along the ventral surface of the pedal retractor muscles. The demibranchs of *Semele* are plicate and heterorhabdic while those of *Scrobicularia* are smooth and homorhabdic (Rice, 1897). According to Ridewood (1903) each plica contains 32-35 filaments in *Semele*.

The ciliation of the gills has been described for *Semele decisa* by Kellogg (1915) and for *Scrobicularia plana* by Atkins (1937) and Yonge (1949). Particulate material from substrate detritus is sucked into the mantle cavity by the incurrent siphon, then swept up over the gills which direct it ventrally to the margin of the inner demibranch and thence to the labial palps and the mouth. There is no forward-running current along the gill axis in *Semele* as there is in *Scrobicularia*. Pseudofaeces are collected ventrally in the vicinity of the cruciform muscle. Specialized siphonal and parasiphonal organs are not present in *Semele*. In addition, there is no definite ventral mantle fold or ridge that creates a ventral channel, as is typical of tellinids (Boss and Kenk, 1964).

The structure of the alimentary canal is similar to that of *Scrobicularia plana* as described and figured by Graham (1934). The mouth is a narrow slit-like aperture formed by the medial portions of the labial palps.

A short straight esophagus leads directly to the stomach, which is surrounded by the digestive gland. The combined style sac and midgut leave the stomach posteroventrally. The intestine is long and greatly convoluted in the viscera. The rectum extends through the pericardial cavity and is enveloped by the ventricle; it passes posteriorly around the outer curvature of the posterior adductor muscle and terminates at the anus near the opening of the excurrent siphon. The intestine and the rectum generally contain compacted fecal pellets.

The heart is in the elongate pericardium, which extends between the posterior retractor muscles and the posterior wall of the viscera; it is partially covered by the upturned inner lamella of the outer demibranch. An indistinct pericardial gland has been reported along the anterodorsal portion of the pericardial walls (White, 1942). The bilaterally paired auricles are thin walled and small relative to the rather extensive, subtriangular, thick-walled median ventricle which surrounds the rectum. A so-called bulbus arteriosus (Schröder, 1916) may be present, investing the rectum in the posterior portion of the pericardium.

The kidneys are granular and compacted structures beneath the pericardium; the renopericardial connection is an elongate and slit-like structure on the posterior dorsal surface of the kidney which communicates directly to the pericardial cavity (Odhner, 1912). The kidneys empty via the nephroproct externally and separately from the gonads in a common lateral urogenital sinus.

The structure of the nervous system of *Semele solidum* has been thoroughly discussed by Schröder (1916). In its general pattern the nervous system is very much like that of *Psammobia vespertinalis* (Duvernoy, 1853) and *Gari tellinella* (Graham, 1934). Anteriorly on the entad surface of the anterior adductor muscle are the paired cerebropleural ganglia which are united by a dorsal commissure and which give rise to the

anterior pallial nerves as well as to the branches which innervate the anterior adductor muscle. From the medial posterior portions of the cerebropleural ganglia, the lateral cerebropleural-pedal connectives arise and course posteroventrally to the united pedal ganglion in the foot. Numerous branches of nerves from the pedal ganglion innervate portions of the pedal retractors, pedal protractors, and pedal intrinsic musculature, as well as the ventral portion of the viscera. From the posterolateral part of the cerebropleural ganglia, the bilaterally paired cerebropleural visceral connectives lead posteriorly to the visceral ganglion on the entad surface of the posterior adductor muscle. The visceral ganglia are united or compacted into a single bilobate ganglion. Extending anterolaterally from the visceral ganglion are the branchial and nephridial nerves. Posteroventrally the visceral ganglion gives rise bilaterally to the posterior adductor nerve, the siphonal nerves, and the posterior pallial nerve.

Semele is dioecious. The gonad is embedded in the dorsal portion of the foot and surrounds much of the style sac and midgut. A genital tube opens into the suprabranchial chamber in the vicinity of the nephroproct in a common urogenital sinus. The reproductive biology of *Cumingia tellinoides*, a member of the Semelidae, has been studied in detail (Grave, 1927; Costello, *et al.*, 1957). Complete metamorphosis takes 16-24 days in that species, and swimming veligers develop within 2 days after fertilization. Species of *Semele* probably exhibit a similar embryological pattern although no specific data relating to *Semele* itself are available.

SYSTEMATIC TREATMENT

Superfamily Tellinacea

Family Semelidae Stoliczka 1871

Genus **Semele** Schumacher

Semele Schumacher 1817. Essai Nouv. Syst. Habit. Vers testaces, pp. 53, 165, 277, pl. 18, fig. 2 (type-species by monotypy, *Tellina reticulata* 'Linnaeus' Spengler 1795, non Linnaeus 1767 [= *Tellina proficua* Pulteney, 1799]).

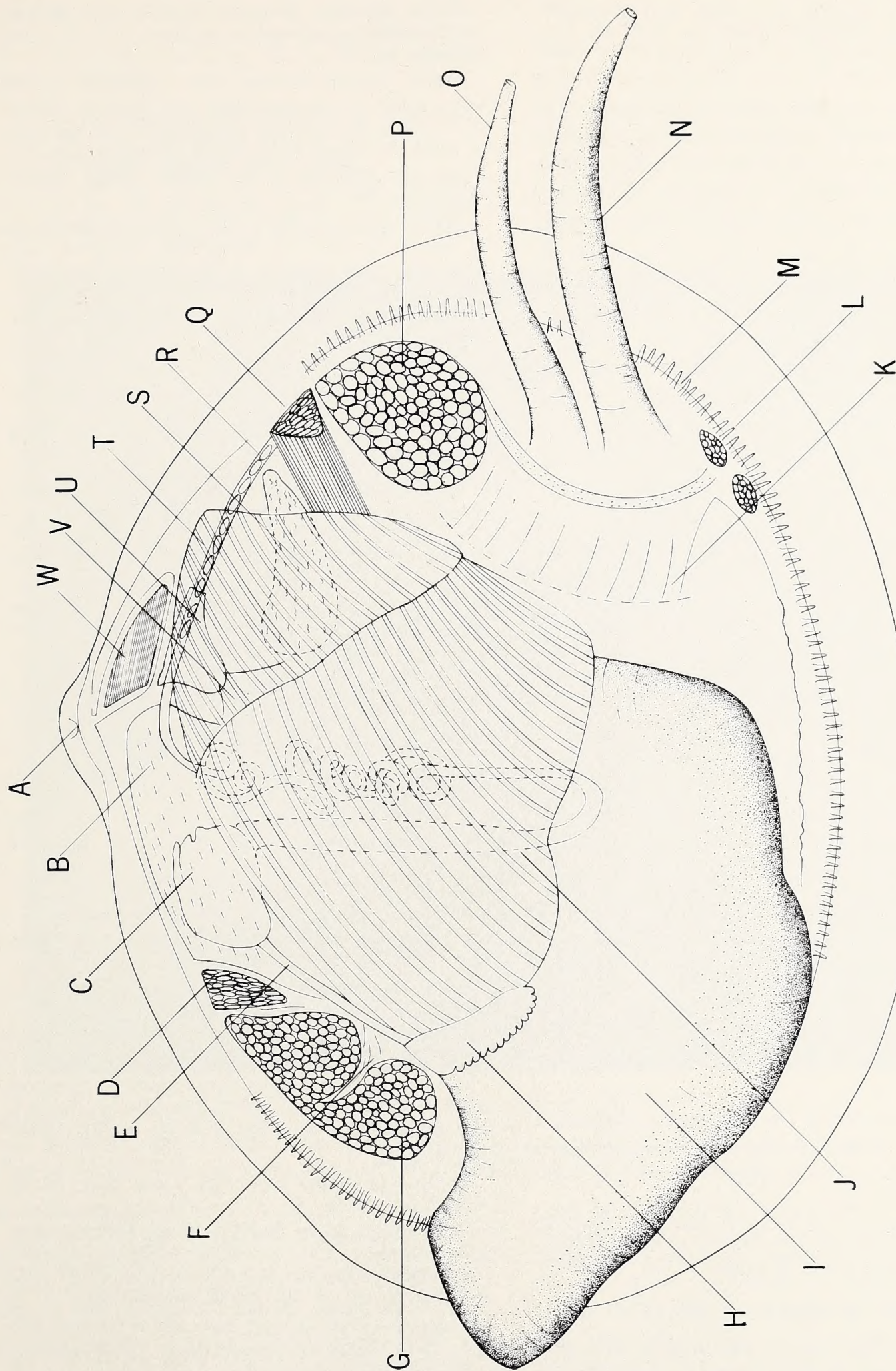


Plate 3. Semidiagrammatic illustration of the anatomy of *Semele purpurascens*. Specimen with the left valve removed to show general structural features. Length of specimen about 25 mm. A — umbo; B — digestive diverticulum; C — stomach; D — anterior pedal retractor muscle; E — esophagus; F — pedal protractor; G — anterior adductor muscle; H — labial palp; I — foot; J — ventral demibranch; K — siphonal retractor muscles (dotted line shows where these muscles have been removed); L — cruciform muscle; M — tentacles of mantle fold; N — incurrent siphon; O — excurrent siphon; P — posterior adductor muscle; Q — posterior pedal retractor muscle; R — rectum with fecal pellets; S — kidney; T — dorsal demibranch; U — ventricle; V — auricle; W — resilium.

Amphidesma Lamarck 1818. Anim. s. Vert., 5: 489 (type-species, by subsequent designation, Children, 1823, p. 301, *Amphidesma variegata* Lamarck 1818 [= *Venus purpurascens* Gmelin 1791]).

Elegantula de Gregorio 1884, Bull. Soc. Malac. Ital., 10: 317 (type-species, by monotypy, *Semele fazisa* de Gregoria 1884 [= *Amphidesma striata* Reeve 1853], teste Lamy 1914, p. 316).

The shells of species of *Semele* tend to be elongate-ovate to subcircular, subequilateral, and more or less equivalve. The ligament is divided into a small, obscure, elongate external element and a strong, developed internal element situated in a chondrophore. Both cardinal and lateral dentition is developed; two cardinal teeth and two lateral teeth are in each valve; the lateral dentition of the right valve is more strongly developed than that of the left. The pallial sinus is large, extensive, frequently reaching beyond the center of the valves, rounded anteriorly, and usually not confluent with the pallial line below. The sculpture is radial, concentric, acentric, or a combination thereof.

The group named *Syndesmyella* by Sacco (1901), with *S. pliovoides* Sacco as type-species by monotypy, was included in the synonymy of *Semele* by Dall (1900); however, the configuration of the right lateral dentition shown in the figures given by Sacco indicate that this name may be better construed as a synonym of *Abra* Lamarck.

Semele may be divided into two groups, *Semele* s.s. with shells of larger size and stronger lateral dentition and *Semelina*, with shells that are smaller and with weaker lateral dentition, particularly in the left valve.

Once considered a western Atlantic *Semele*, the *Amphidesma transversum* Say (1831, Amer. Jour. Conch., 3: 28, pl. 23, middle) from the coast of Georgia is the European *Scrobicularia plana*. The locality has been shown to be in error (Dall, 1900).

Semele proficua (Pulteney)

Plate 4, fig. A; Plate 5, fig. A; Plate 7, fig. A; Plate 8, fig. A; Plate 10, fig. A; Plate 12, figs. A, B, C, D, F.

Tellina reticulata "Linnaeus" Spengler 1798. Skrivter af Naturhistorie Selskabet, København, 4(2): 115, non Linnaeus 1767.

Tellina proficua Pulteney 1799. Catalogues of the birds, shells . . . of Dorsetshire [in] Hutchin. History of Dorset, p. 29, pl. 5, fig. 4 (type-locality, on the sands at the North Shore, Poole and at Weymouth, here corrected and restricted to St. Thomas, Virgin Islands; types not known).

Tellina decussata Wood 1815. General Conchology, p. 190, pl. 43, figs. 2-3 (type-locality not given; here designated as St. Thomas, Virgin Islands; types, "Linnaean Society's Cabinet").

Amphidesma orbiculata Say 1822. Jour. Acad. Nat. Sci. Philadelphia, ser. 1, 2: 307 (inhabits the coast of Georgia; possible syntypes, ANSP 53267).

Amphidesma radiata Say 1826. Jour. Acad. Nat. Sci. Philadelphia, ser. 1, 5: 220 (southern shores of East Florida . . . on the coast of Georgia; syntypes, ANSP 53283), non Reeve 1853.

Amphidesma subtruncatum Sowerby 1833. Catalogue Amphidesma, Conch. Ill. (West Indies; *nomen nudum*); Reeve 1853, Conch. Icon. vol. 8, *Amphidesma*, fig. 11 (Island of Nevis, West Indies, in sandy mud at 6 fathoms; holotype, BMNH).

Amphidesma jayanum C. B. Adams 1845. Proc. Boston Soc. Nat. Hist., 2: 10 (Jamaica; lectotype, selected and figured by Clench and Turner, 1950, Occ. Papers Harvard, 1(15): 298, pl. 43, figs. 3-4, MCZ 186109).

Lucina icterica Reeve 1850. Conch. Icon., vol. 6, *Lucina*, pl. 10, figs. 60 a-b (type-locality not given, here designated as St. Thomas, Virgin Islands; syntypes, BMNH) 1853. Conch. Icon., vol. 8, *Amphidesma*, sp. 36.

Amphidesma duplicata Reeve 1853. Conch. Icon., vol. 8, *Amphidesma*, pl. 3, fig. 14 (Antigua; types not known).

Amphidesma decora Reeve 1853. Conch. Icon., vol. 8, *Amphidesma*, pl. 3, fig. 15 (type-locality not given; here designated as St. Thomas, Virgin Islands; syntypes, BMNH).

Amphidesma luteola Reeve 1853. Conch. Icon., vol. 8, *Amphidesma*, pl. 6, figs. 42 (type-locality not given; here designated as St. Thomas, Virgin Islands; holotype BMNH).

Amphidesma compta Reeve 1853. Conch. Icon., vol. 8, *Amphidesma*, pl. 7, fig. 51 (type-locality not given; here designated as St. Thomas, Virgin Islands; holotype, BMNH).

Amphidesma amoena Reeve 1853. Conch. Icon., vol. 8, *Amphidesma*, pl. 7, fig. 52 (type-locality not given; here designated as St. Thomas, Virgin Islands; holotype, BMNH).

Amphidesma australe 'Sowerby' Hanley 1856. Rec. Shells., p. 342, pl. 12, fig. 8, non Sowerby 1833.

Semele carolinensis Conrad 1867. Amer. Jour. Conch., 3(1): 14 (Waccamaw, South Carolina; types, missing, teste Moore, 1962, p. 47).

Semele phryne Angas 1879. Proc. Zool. Soc. London (1878), pt. 4, p. 860, pl. 54, fig. 4 (type-locality not given; here designated as St. Thomas, Virgin Islands; holotype, BMNH).

Semele mediamericana Pilsbry and Lowe 1932. Proc. Acad. Nat. Sci. Philadelphia, 84: 92, pl. 12, figs. 1, 1a, 2 (Nicaragua; holotype, ANSP 53295).

Semele aurora Tursch and Pierret 1964. Veliger, 7(1): 35, figs. 1-3 (off Rio de Janeiro, in 30 fathoms; holotype, Stanford Univ. Paleo. Type Coll., no. 9736).¹

Description. Shell extending to 47 mm in length and to 42 mm in height, suborbicular, subsolid, nearly equilateral, equivalve, with a flexure to the right posteriorly. Umbos centrally located, somewhat inflated, slightly prosogyrous, often with concentrations of reddish or yellowish coloration. Anterior and ventral margins broadly and evenly

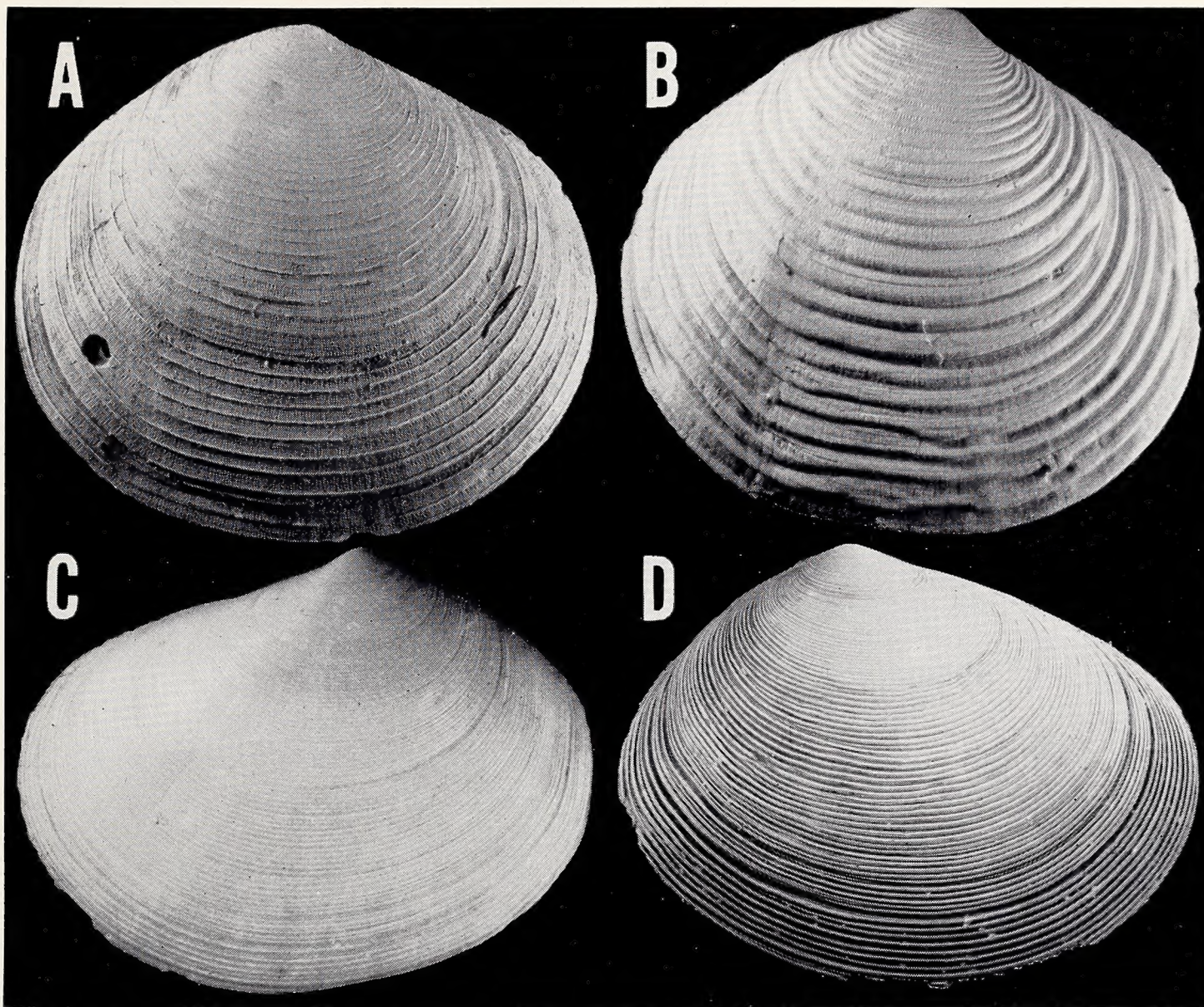


Plate 4. A—external view of the right valve of *Semele proficua*, USNM 83350, Bermuda (length 25.2 mm.); B—external view of the right valve of *Semele modesta*, MCZ 232214, Ascension Island (length 38.8 mm.); C—external view of the left valve of *Semele casali*, MCZ 258310, off Bermeja Head, Argentina (length 20.9 mm.); D—external view of the right valve of *Semele casali*, USNM 170212, off Rio de la Plata (length 19.6 mm.).

¹Subsequent to this description, Klappenbach (1968), followed by Figueiras and Sicardi (1968), placed *aurora* in the synonymy of *martinii* Reeve, which is herein considered a synonym of *modesta* Reeve. The type-specimens of both *modesta* and *martinii* possess the characteristic heavy rib-like concentric sculpture; *aurora* is characterized by its bright colored, radial strips, a feature so widespread in *proficua* populations that Say erected his species *radiata* for such specimens.

rounded; posterior margin irregularly and weakly convex with slight postventral indentations more noticeable in right valve; anterior dorsal margin short and very weakly concave; posterior dorsal margin longer, sharply descending, and slightly convex. De-

pending on convexity or posterior margin, outline of shell with broad, blunt, posterior truncation. Concentric sculpture consisting of regular raised lirations, spaced equidistantly (about 0.3-0.6 mm apart), stronger peripherally, and often stronger on right valve. Radial sculpture consisting of slightly irregular, weak, and slightly raised lirations (about 8-12 per mm) crossed by stronger concentric sculpture, producing minute cancellate pattern. Concentric growth lines present and becoming more numerous and more closely spaced peripherally. Extremely weak biangulate ridges posteriorly, associated with posterior flexure. Area between weak ridges convex in left valve, concave in right. Weak ridges radiating from umbo along anterior and posterior dorsal margins. Ligament opisthodontic, consisting of internal oblique resilium in elongate chondrophore and of obsolete elongate, thin, external portion. Weak elongate escutcheon in left valve. Lunule conspicuous, though variable, elongate, cordiform, and generally stronger in right valve. Hinge line well developed. Left cardinal complex consisting of developed, moderately strong, anterior cardinal tooth and of thin, elongate posterior cardinal tooth, often lost, broken, or coextensive with anterior margin of resilium. Slightly protuberant left anterior lateral tooth closer to umbo and more strongly developed than distal, weak posterior lateral tooth. Right cardinal complex consisting of thickened anterior cardinal tooth coalesced with base of lunule and of elongate, thin, dorsoventrally rectangular posterior cardinal tooth, often broken or lost. Right anterior lateral tooth subproximal, strong, protuberant and posterior lateral tooth distal, laminate, and slightly upcurved. Muscle scars generally poorly impressed and internal surface of valves highly polished. Pallial sinus narrowed, obliquely ascending, free from pallial line ventrally, a little more extensive in right valve and often with fan-shaped pallial retractor muscle scars evident. Interior of

valves irregularly pitted by mantle musculature. Whitish externally and internally with suffusions of yellow internally and/or blotches of brownish red; sometimes yellow, pink, or red umbonal concentrations of color and rarely reddish or pink radial rays.

length	height	width	
46.3 mm	42.0 mm	18.5 mm	St. Thomas
39.0	35.4	17.0	Veracruz, Mexico
35.0	32.5	—	Murrell's Inlet, South Carolina
33.4	29.3	19.4	lectotype of <i>Amphidesma jayanum</i> C. B. Adams
24.9	22.4	11.1	Apalachicola, Florida
19.0	16.4	7.8	St. Thomas
9.8	8.4	3.4	Half Moon Reef, Texas
3.8	3.3	1.5	Half Moon Reef, Texas

Remarks. *Tellina reticulata* Linnaeus 1767 is based upon plate 43, figure E, of Rumphius' *Amboinsche Rariteitkamer*.¹ This species was called *Chama scobinata* by Rumphius and he noted that it did *not* occur in Amboina. Linnaeus (1767) gave the locality 'In India' upon the authority of Tesdorf. Dodge (1952) has shown that the figure of Rumphius, the description of Linnaeus, the cited locality, and the absence of an authoritative specimen in the Linnaean collection all support the thesis that this named entity is unidentifiable and that the specimen was oriental in origin and not from the West Indies.

It is necessary to note that Linnaeus (1758) cited exactly the same figure of Rumphius for his *Tellina scobinata* as well as plate 76, figure E of Gualtieri's *Index Testarum Conchyliorum* (1742). In the 12th edition of the *Systema* (1767), Linnaeus moved the reference to Rumphius from *scobinata* to *reticulata*. Clearly he was differentiating the species represented by the figures of Gualtieri and Rumphius. The shell figured by Gualtieri represents *Tellina scobinata* Linnaeus 1758, as presently understood,

¹Not plate 42 as cited by Dodge (1952). The plates 42 and 43 of Rumphius' 1705 edition were reversed in the 1741 edition and plate 42 (1705) was incorrectly renumbered plate 43.

and his illustration should be construed as the type-figure of that species. The figure given by Rumphius represents an unidentifiable lucinid, probably a *Codakia* as suggested by von Martens (1902). This is not the species *Semele proficua* (Pulteney), the *Tellina reticulata* "Linnaeus" of post-Linnaean authors.

Chemnitz (1782), in his non-binomial work, used *Tellina reticulata* Linnaeus and stated that it came from the West Indian Sugar Islands (Virgin Islands); Spengler (1798) also followed this interpretation of the Linnaean species; Schumacher (1817), in establishing the generic name *Semele*, used this interpretation for the type-species. Even Pulteney, who first described *proficua*, used *reticulata* in 1813.

The names *amoena*, *compta*, *luteola*, and *decora* were introduced by Adams at the July 1853 meeting of the Zoological Society of London, but they were not formally published in the Proceedings until 25 July 1854. In the *Conchologia Iconica*, Reeve cites Adams as their author, but an interpretation of priority requires the citation of Reeve as author.

Semele carolinensis Conrad 1867 is based upon the interpretation of *Amphidesma orbiculata* Say of Tuomey and Holmes (1856) and their figure 4 of plate 23; the type-specimen can not be found in the Tuomey and Holmes collection at the American Museum of Natural History, New York. As Olsson (1961) has pointed out, *Semele medi-americana* Pilsbry and Lowe is not from the Pacific coast of Nicaragua and is, in fact, *proficua*.

Ample historical synonymies of *S. proficua* are presented by Lamy (1914) and Weisbord (1964).

One of the important variations in *S. proficua* is distribution of coloration within the shell. Externally most specimens are a dirty grey-white while internally they are white with central suffusions of yellow; the internal surface of the valves is highly polished and

its periphery is almost always white. The degree of yellow suffusion is variable, and while some specimens have only a vague indication of yellow coloration internally, others are bright canary yellow. Irregular brownish, reddish, or purplish blotches may supplement the yellow interior of the valves; specimens of this kind were pictured by Wood (1815, pl. 43, figs. 2-3) as *Tellina decussata*. Umbonal concentrations of reddish orange or pink are often coupled with similarly colored radiations which are visible externally and internally; the synonyms *radiata* Sowerby and *aurora* Tursch and Pierret appear to have been founded on this particular color variation. In addition, some reddish coloration may be concentrated along the concentric growth rings.

Specimens in the early lineage of *S. proficua* from the upper Miocene of the Choctawhatchee formation of Florida were named as a subspecies, *harveyensis*, by Mansfield (1932); they are distinct from typical Recent *proficua* in their much greater size. In the Pliocene, *S. proficua* occurs in the Caloosahatchee marl of Florida, the Waccamaw formation of South Carolina, and the lower Mare formation of Venezuela (Tuomey and Holmes, 1856; Dall, 1900; Weisbord, 1964). There are numerous Pleistocene localities, including South Carolina, Florida, Cuba, Venezuela, Brazil, and Argentina (Holmes, 1858; Dall, 1900; Aguayo, 1938; Weisbord, 1964; von Ihering, 1907; Carcelles, 1944).

Semele lenticulare (Sowerby), which ranges from Panama southward to Peru, is the eastern Pacific analog of *Semele proficua*. Olsson (1961) stated that the principal distinguishing characteristic is one of size; *S. lenticulare* is smaller than *S. proficua*. *Semele cordiformis* Holten [= *S. sinensis* (Adams)] of the Philippines and adjacent areas of the South China Sea appears to be an Indo-Pacific analog of *S. proficua* (Hidalgo, 1903; Skarlato, 1965). It is most probable that all three of these forms arose from a widely

distributed cosmopolitan Tethyan ancestor. Having become geographically isolated, separate populations gave rise to distinct biological species which have been treated separately taxonomically and which are very similar morphologically.

Semele proficua normally inhabits shallow water and prefers sand or sandy mud substrates in which it lies buried, on its left side. Various depths have been cited in the literature. Off the coast of West Florida, *S. proficua* has been found in 3-6 fathoms by Perry and Schwengel (1955) and in 16 fathoms by Adams and Kendall (1891). Parker (1956; 1959) has reported it in the upper sound of the Mississippi Delta and, as an indicator species, in the open high-salinity bays and sounds of the Texas coast. A curious and, no doubt, unusual habitat was recorded by Moore (1961) who found *S. proficua* living several feet above the bottom in dead oyster shells which were attached to a submerged wreck on the north side of Ship Island, Mississippi. Stanley (1970) noted that *S. proficua* was a rapid burrower inhabiting shallow water grass flats; he also suggested that the species might be a suspension feeder.

Range. The southernmost locality from which this species has been recorded is that noted by Carcelles (1944) who found it as far south as Isla Leones in the Bahia Bustamante along the northern shores of the Golfo San Jorge, Argentina, at 45°00'S, 65°30'W. I have not been able to obtain specimens from that far south but have seen them from the Golfo San Matias. The northernmost occurrence of *S. proficua* is at Beaufort, North Carolina, where it is found commonly in the sound (Hackney, 1944). However, a single lot in the U. S. National Museum is questionably indicated as being from Virginia, and many of the published ranges of the species include this lot (Dall, 1903; Maury, 1920). The species is widely distributed in the temperate and tropical waters of the western Atlantic, from North Carolina

through the Gulf of Mexico and Caribbean Sea along the coast of South America to the Golfo San Jorge in Argentina. This species lives in depths to 30 fathoms (55 m).

Specimens examined. VIRGINIA: ? (USNM). NORTH CAROLINA: Fort Macon, Beaufort (USNM); Pivers Island (USNM; MCZ); Bogue Sound (USNM); Wrightsville Beach; Southport (both MCZ). SOUTH CAROLINA: Myrtle Beach; Murrell's Inlet; Charleston (all USNM). FLORIDA: St. Augustine (USNM); Cape Canaveral (MCZ); Lake Worth; off Miami, in 20-30 fathoms; off Government Cut, Miami, in 3-30 fathoms (all USNM); Virginia Key (MCZ); off Bear's Cut, in 18-20 fathoms; off Fowey Light, in 6-25 fathoms (both USNM); Turtle Harbor, in 6 fathoms; Long Key; Pirates Cove, Sugarloaf Key; off American Shoals (all MCZ); Hawk Channel, in 3-20 fathoms (USNM); Key West; Boca Grande (both MCZ); Tortugas; Cape Sable, in 1½ fathoms (both USNM); Pavilion Key; Shell Island, Cape Romano; Horse Key; Marco; Naples (all MCZ); Bonita Beach; Fort Myers; Punta Rassa; Sanibel, in 6-15 feet; Captiva; Charlotte Harbor; Grove City; Gasparilla Key; Sarasota Bay; Egmont (all USNM); Mullet Key; Pinellas Point; Pass-a-Grille; Madeira Beach (all MCZ); Cedar Keys; Indian Pass, Apalachicola; Panama City (all USNM). LOUISIANA: Grande Isle; Grand Lake, Cameron County (both USNM). TEXAS: Galveston; Pass Cabello; Half Moon Reef; Matagorda Bay; Caranahua Bay (all USNM); Port Aransas (MCZ). MEXICO: Tuxpam; 15 miles N of Tecolutla; Tecolutla; Veracruz; Alvarado (all MCZ). BRITISH HONDURAS: E. side of Sittee Island (16°48'35"N; 88°15'00"W); Seine Bight, Placoneia Lagoon (16°35'10"N; 88°22'15"W) (both ANSP). HONDURAS: Ruatan Island (USNM). PANAMA: Colon (MCZ). BERMUDA: Castle Roads, Castle Harbour; Harrington Sound; Hungry Bay; Agars Island (all MCZ). BAHAMA ISLANDS: Dick's Point, Nassau, New Providence; Sandy Point, Savannah Sound, and Governor's Harbour, Eleuthera Island; Orange Creek and Arthurstown, Cat Island; Simms, Long Island; Matthew Town, Great Inagua (all MCZ). CUBA: Arroyos; Santa Lucia, in 2 fathoms; Esperanza, in 2-3 fathoms (all USNM); Morrillo Beach, Bahia Honda (MCZ); Cabanas Harbor, in 2-3 fathoms (USNM); Cayo Frances (MCZ); Cienfuegos Harbor (USNM); Caletón de Don Bruno; Rancho Aluna, Punta de los Colorados; Nicaro, Mayari; Guantanamo (all MCZ). JAMAICA: Green Island Harbour; Rockfort; Port Maria; Robins Bay; Harboreale; Black River; Great Pedro Bay; Old Harbor; Hunt's Bay; Port Royal; Kingston Harbor; Palisades (all USNM). HISPANIOLA: HAITI: Cape Hatian; Bizoton (both USNM); Miragoane (MCZ); Tiburon; Damassins; Port Salut; Torbeck; Les Cayes (all USNM); Aquin (MCZ); Baie Anglaise; Saltrou (both USNM). SANTO DOMINGO: Monte Cristi (MCZ); Maimon Bay (USNM); Santa Barbara de Samana (MCZ). PUERTO RICO: Bahia de Añasco; Punta Guanajibo (both MCZ); El Desecheo Island, Mayaguez (USNM); Guanica (MCZ). VIRGIN

ISLANDS: Anegada (ANSP); Tortola; St. Johns; St. Thomas (all USNM). LESSER ANTILLES: Basseterre, St. Kitts (ANSP); Antigua; Post Castres and Marigot Harbor, St. Lucia (both MCZ); Villa, St. Vincent (USNM); Barbados (MCZ); Bathsheba and St. Lawrence, Barbados (USNM); Little Bacaye Harbor and Hardman Bay, Grenada (both ANSP); Dry Rocks, E side of Buccoo Reef, Tobago; Point à Pierre and Saline

MCZ); Ilha Grande, Distrito Federal; São Sebastião; São Paulo; São Francisco; Florianopolis (all USNM). URUGUAY: Lobos Island; Puerto La Paloma (both USNM). ARGENTINA: *Albatross I* Station 2765, off Rio de la Plata, 11 fathoms; *Albatross I* Station 2766, off Rio de la Plata, 11 fathoms (both USNM); *Hassler* Station, 41°40'S, 63°13'W, Golfo San Matias, in 30 fathoms (MCZ); Puerto Madryn, Golfo Nuevo (ANSP).

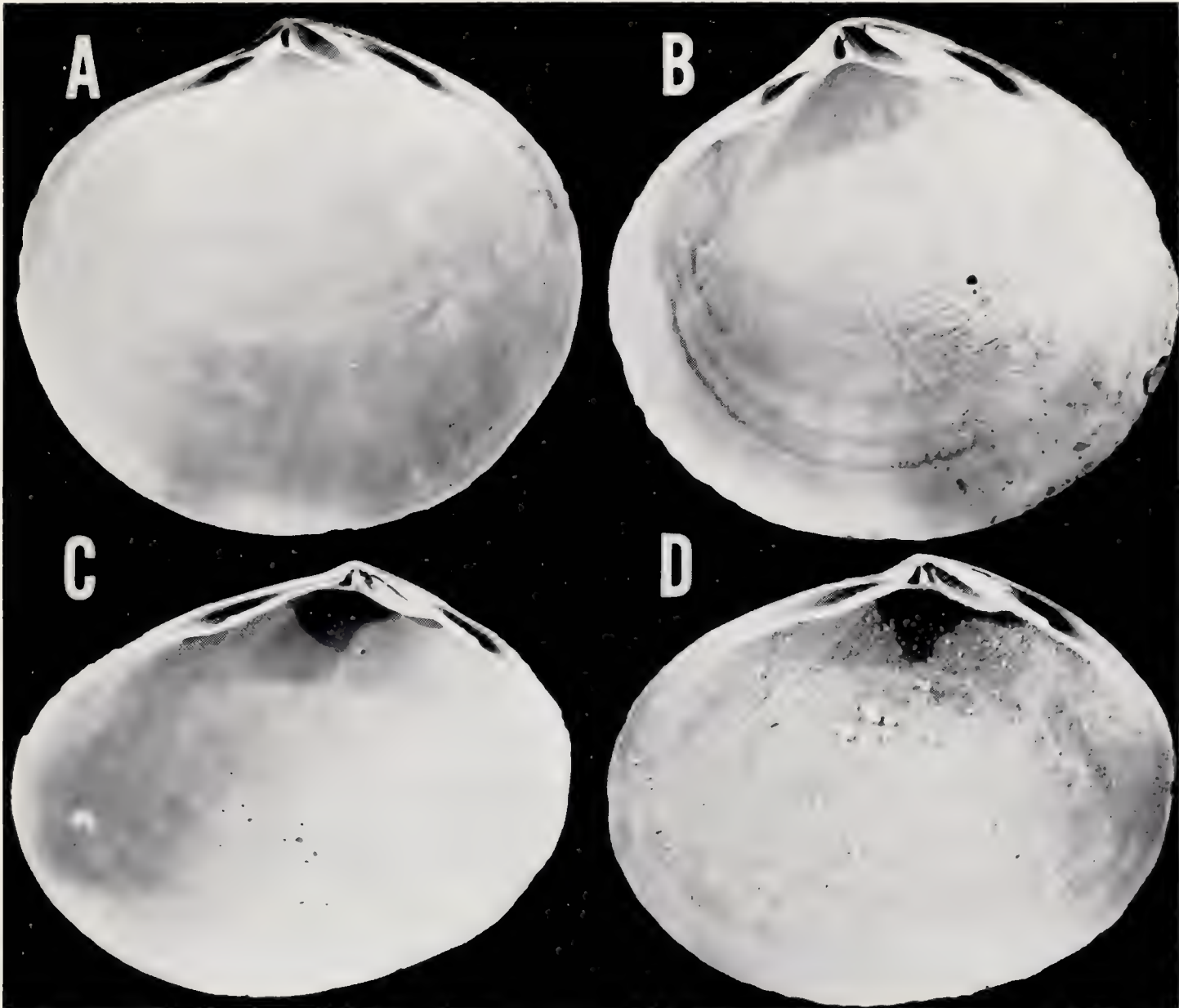


Plate 5. Internal view of the right valve. A—*Semele proficua*, USNM 441153, Port Maria, Jamaica (length 29.0 mm.); B—*Semele modesta*, MCZ 232214, Ascension Island (length 21.4 mm.); C—*Semele casali*, MCZ 258310, off Bermeja Head, Argentina (length 21.5 mm.); D—*Semele purpurascens*, USNM 53666, Key West, Florida (length 21.7 mm.).

Bay, Trinidad (both MCZ). CARIBBEAN ISLANDS: Curaçao (USNM). COLOMBIA: Cartagena; Puerto Colombia (both USNM). VENEZUELA: Barcelona (USNM); Margarita Island (MCZ). BRAZIL: Belém (MCZ); Ceara; Bahia (both USNM); Ilha de Maré, Todos Santos Bay, in 5-6 fathoms; Santo Antonio and Manginhos, Ilha de Itaparica; Ilheos; Praia de Boa Viagem, Nitheroy; Ilha de Guanabara; Rio de Janeiro (all

Semele modesta (Reeve)

Plate 4, fig. B; Plate 5, fig. B; Plate 7, fig. B; Plate 8, fig. B; Plate 10, fig. B.

Amphidesma modesta Reeve 1853. Conch. Icon., vol. 8, *Amphidesma*, pl. 6, figs. 35a-b (Cape Palmas, West Africa; syntypes, BMNH).

Amphidesma martinii Reeve 1853. Conch. Icon., vol. 8, *Amphidesma*, pl. 6, fig. 43 (Rio [de Janeiro]; holotype, BMNH).

Semele modesta Reeve. Adams 1854. Proc. Zool. Soc. London (1853), p. 95 (Cina Seas [in error]).

Semele martini Reeve. Adams 1854. Proc. Zool. Soc. London (1853), error for *martinii* Reeve.

Description. Shell extending to 31 mm in length and about 30 mm in height, suborbicular, subsolid to solid, nearly equilateral, nearly equivalve with right valve slightly more convex and inflated and with posterior flexure to right. Umbos central, elevated, blunt, and prosogyrous. Anterior margin generally evenly and broadly rounded; ventral margin straight to slightly convex and rising behind at postbasal arcuation; anterior dorsal margin short, straight to concave; posterior dorsal margin longer, straight to weakly convex; posterior margin straight to broadly rounded and convex. Sculpture consisting of strong raised concentric ribs, 0.2-0.3 mm broad and about 1 mm apart. Weak radial lirations (12-15 per mm) on intercostal depressions and particularly evident in immature stages on disc. Weak posterior ridge coincident with postbasal arcuation. Ligament consisting of external, obsolete opisthodetic portion and of strong, yellow, internal resilium. Lunule subcordiform, often reddish and more extensive in right valve; escutcheon obsolete, narrow and lanceolate. Hinge line well developed. Left cardinal complex consisting of single, subsolid anterior tooth and of subobsolete, narrow posterior tooth, often lost, broken, or coalesced with resilial element. Anterior lateral tooth subproximal and more or less equal in strength to distal posterior lateral tooth. Right cardinal complex consisting of single thickened, subdeltoid, anterior tooth often coalesced with floor of lunule, and of single strong posterior tooth. Anterior lateral tooth upcurled, closer to umbonal area and stronger than distal posterior lateral tooth. Muscle scars generally poorly impressed. Anterior adductor muscle scar elongate-subquadrate; posterior scar irregularly subquadrate. Pallial

sinus arising gently and narrowly rounded in front. Shell dirty white to yellowish externally; rarely with apricot suffusions internally; polished and shining internally; lunule often reddish; additional reddish flecks along dorsal marginal area.

length	height	width (*hemidiameter)	
30.7 mm.	29.1 mm.	7.5 mm.*	St. Helena
28.5	25.9	6.2*	Ascension Island
25.2	25.5	6.5*	Abrolhos Archipelago
22.9	20.2	9.5	St. Helena
18.4	18.2	5.0*	Ascension Island
13.6	12.2	2.5*	St. Helena

Remarks. This is another species (see the *Synonymy* and *Remarks* under *S. proficua*) for which the name must date from Reeve (1853) because his usage of Adams' names in the *Conchologia Iconica* antedates Adams' paper which, though presented to the Zoological Society of London 1853, was not published until 1854. The locality "China Sea" for *S. modesta* given by Adams was in error; the type-lot in the British Museum (Natural History) is marked as coming from Cape Palmas, West Africa, as quoted by Reeve upon the authority of Redfield.

The type specimen of *S. martinii* agrees with *S. modesta* in its characteristically strong rib-like concentric sculpture. That some of these ribs might be irregular, confluent, and therefore dichotomous is a reflection of the variation of this sculpture in *S. modesta* and is not to be construed as a specific diagnostic trait.

The great similarity in the configuration of the hinge and of the pallial muscle scar, combined with the presence of radial striations in immature stages, indicate that *S. modesta* is closely related to *S. proficua*. However, the two species differ in a number of respects. The external concentric sculpture of *modesta* consists of raised strong, rather widely spaced riblets, which are about 0.2-0.3 mm broad and usually more or less regularly distributed over the surface of the valve. In contradistinction, the concentric sculpture of *proficua* is weak and more closely

spaced; its concentric lirations are not heavy or raised. The outline of the shell of *modesta* is not typically as suborbicular or as subcircular as that of *proficua*; the posterior dorsal slope and the posterior margin are such as to give the outline of the shell of *modesta* a slightly more truncate appearance. Further, the fine radial striations which occur centrally in both species become obscure peripherally in *modesta*.

In terms of variation, *S. modesta* presents a considerable range of shapes, though the tendency toward posterior truncation is always evident. As reported by Dohrn (1880) specimens have reddish flecks or concentrations of coloration on the lunule and escutcheon, and dorsal margins; however, not all specimens exhibit this characteristic, and for that reason color is not diagnostic in the species.

Reeve (1853) originally described *S. modesta* from Cape Palmas, West Africa. Smith (1890a, b) reported it on St. Helena and Ascension Island under the name of "*Semele cordiformis* (Chemnitz)"; he also listed a number of synonyms in his concept of that species, including the recent *S. lenticulare* of the eastern Pacific and *S. proficua* of the western Atlantic. Further, he noted "*S. cordiformis*" from Fernando de Noronha (1890c) and from off Rio de Janeiro in 40 fathoms (1915). Nobre (1909) recorded it from Principe, São Thomé and Fernando Pó. Tomlin and Shackleford (1914) also noted it from Principe, São Thomé, adding Accra as an additional locality, and they disagreed with Smith's inclusion of *modesta* in the concept of "*cordiformis*." Basing their quotation on Smith (1890c), Lopes and Alvarenga (1955) listed "*Semele proficua*" from Fernando de Noronha, although they found no specimens. It is difficult if not impossible to adjudge the validity of some of these records because no description or illustration accompanied their citation in the faunal lists. However, Smith (1890a) did state that the specimens he had agreed with

the figures of *modesta* in Reeve. In "lower Guinea" [= Rio Muni], Dunker (1853) found some valves which he referred to "*S. reticulata*" but which probably are *S. modesta*. Under the name *S. australis*, *S. modesta* has been discovered in a conglomerate of unknown age at São Tiago, Cape Verde Islands (de Rocheburne, 1881). And recently, it has been noted, in addition to the São Tiago locality, at Santa Maria, Sal, Cape Verde Islands (Lecointre and Serralheiro, 1967).

The West African bivalve fauna is known largely through the efforts of Nicklès (1955) who at that time described *Semele lamyi*, which he had previously (1947; 1950; 1952) referred to as "*S. purpurascens*," and which occurs from the Casamance, Senegal to the French Congo. He did not, however, mention *S. modesta* in spite of the reports of the numerous authors previously cited. It is apparent then that there are two West African species of *Semele*, *S. lamyi* and *S. modesta*, which are partly sympatric and which have not been simultaneously considered; both of the West African species differ from their Antillean relatives, *S. purpurascens* and *S. proficua* (see *Remarks* under *purpurascens*).

Range. *Semele modesta* is wide ranging, occurring from the islands of the Gulf of Guinea, along the coast of Central and West Africa through the central South Atlantic islands of Ascension and St. Helena to the offshore reaches of Brazil.

Specimens examined. SOUTH AMERICA: Arquipélago dos Abrolhos, 18°00'S, 38°40'W, off Caravelas, Bahia (USNM); Rio de Janeiro (BMNH). ATLANTIC ISLANDS: Ascension; Georgetown Beach, Ascension; St. Helena (all MCZ). AFRICA: Cape Palmas, Liberia (BMNH).

Semele purpurascens (Gmelin)

Plate 3; Plate 5, fig. D; Plate 6, figs. A, B, C, D; Plate 7, fig. E; Plate 8, fig. D; Plate 10, fig. C.

Venus purpurascens Gmelin 1791. Syst. Nat., Ed. 13, pt. 6, p. 3288, no. 91 (type-locality not given, here designated as Key West, Florida; types not known), *non* Lamarck 1818, *nec* Sowerby 1832.

Tellina obliqua Wood 1815. General Conchology, p. 152, pl. 41, figs. 4-5 (type-locality not given, here designated as Key West, Florida; types 'Linnaean Society's Cabinet'), *non* Sowerby 1817.

Amphidesma variegata Lamarck 1818. Anim. sans Vert., 5: 490 (type-locality, les côtes d'Afrique?, here corrected and designated as Key West, Florida; types, ?Museum d'Histoire naturelle Geneva).

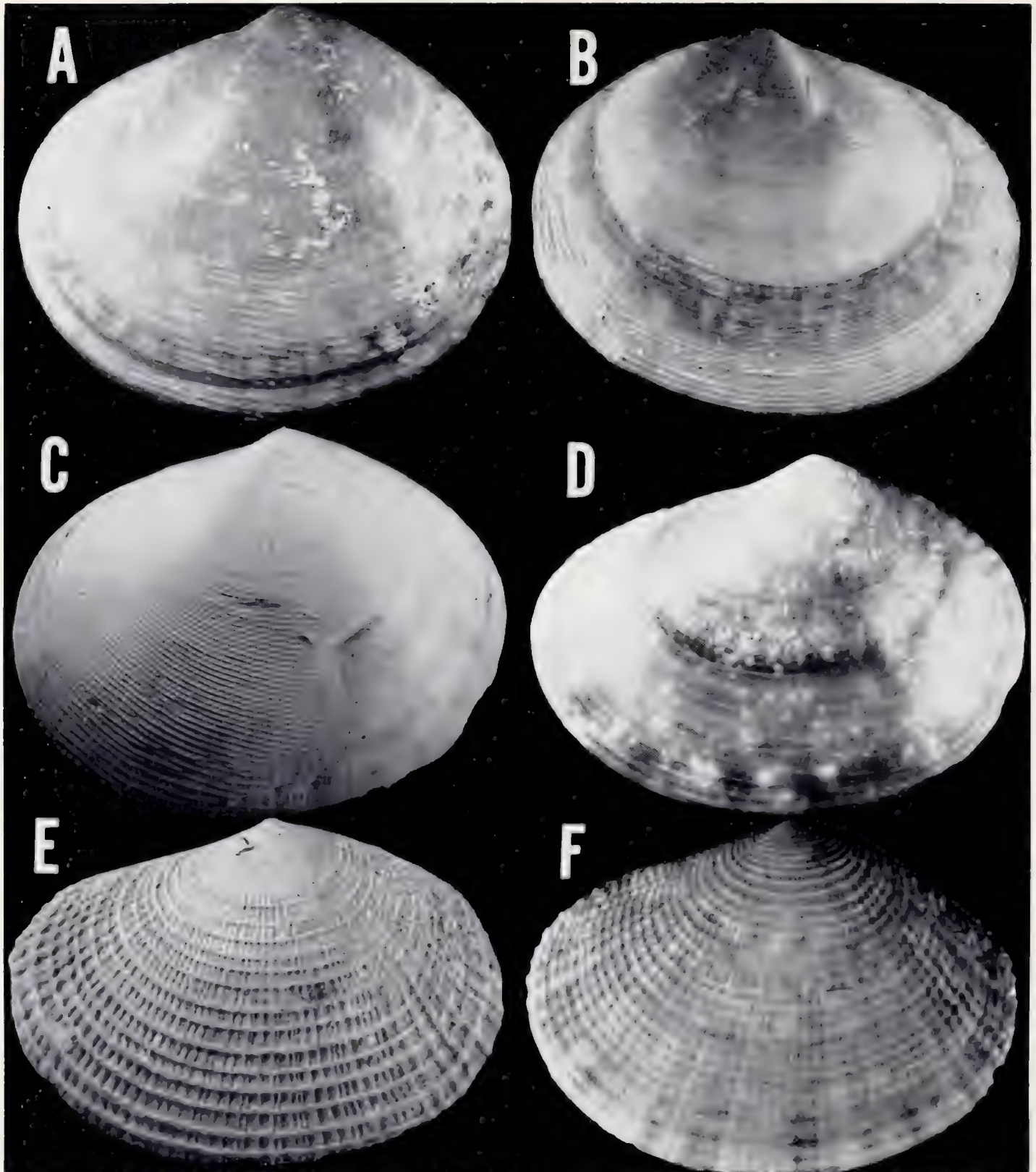


Plate 6. A—external view of the left valve of *Semele purpurascens*, USNM 53666, Key West, Florida (length 31.7 mm.); B—external view of the right valve of *Semele purpurascens*, USNM 53666, Key West, Florida (length 24.2 mm.); C—external view of the left valve of *Semele purpurascens*, USNM 53666, Key West, Florida (length 21.5 mm.); D—external view of the left valve of *Semele purpurascens*, USNM 450000, *Eolis* station 75, Key West, Florida (length 14.1 mm.); E—external view of the left valve of *Semele bellestriata*, USNM 438817, *Eolis* station 32, off Sand Key, Florida (length 8.8 mm.); F—external view of the left valve of *Semele bellestriata*, USNM 604757, off Longboat Pass, Florida (length 13.5 mm.).

Amphidesma laeta Reeve 1853. Conch. Icon., vol. 8, *Amphidesma*, pl. 7, fig. 45 (type-locality not given, here designated as Key West, Florida; holotype, BMNH).

Semele ornata Gould 1862. Proc. Boston Soc. Nat. Hist., 8: 281 (Georgia; types missing, not mentioned in Johnson, 1964, p. 119).

Semele formosum "Sowerby" Krebs 1864. The West Indian Marine Shells, p. 106, *non* Sowerby 1833, *teste* Dall 1900.

Description. Shell extending to 36 mm in length and 31 mm in height, irregularly ovate, solid, inequilateral, equivolume, with valve of more or less equal convexity and with posterior flexure to right. Umbos just behind middle, elevated, conspicuous, pointed. Umbonal cavity deep and umbonal area with concentrations of purple or red-orange. Anterior margin broadly to narrowly rounded; ventral margin broadly rounded, rising arcuately posteriorly; anterior dorsal margin gently sloping and more or less straight; posterior dorsal margin more steeply inclined and somewhat convex; posterior margin blunt, forming broad truncation. Sculpture consisting of regularly spaced acentric sulci, most noticeably out of phase with concentric growth rings on left valve. Concentric sculpture generally stronger on posterior dorsal slope of right valve. No radial sculpture developed. No well-defined anterior or posterior ridges in either valve. Ligament opisthodontic, divided into internal and external portions. Yellow, weakly developed external portion of ligament set in weakly defined escutcheon. Internal portion of ligament well developed, short, resting on shallow excavated chondrophore. Lunule short, deep, cordiform, and more strongly developed in right valve. Left cardinal complex consisting of thickened, weakly bifid anterior cardinal tooth and of thin, laminate posterior cardinal tooth adpressed to resilium; anterior and posterior lateral teeth weakly developed. Right cardinal complex consisting of posterior narrowed bifid cardinal tooth and of anterior thickened laminate tooth coextensive with base of lunule; anterior and posterior lateral teeth well developed. Anterior

lateral tooth in both valves closer to cardinal complex than posterior lateral tooth. Internal anterior radial rib developed in left valve. Adductor muscle scars impressed; anterior scar narrower and more semilunate than subquadrate posterior adductor scar. Pallial sinus extensive, larger in left valve, broad, and confluent with pallial line posteriorly. Color yellow, orange or purple, often concentrated umbonally and/or upon disc. Externally disposed in irregular blotches.

length	height	width	
35.4 mm	30.8 mm	—	Rio de Janeiro, Brazil
30.7	25.0	12.2 mm	Tortola, Virgin Islands
25.0	20.3	9.5	Dry Tortugas, Florida
14.2	10.0	4.5	North Bimini Islands, Bahamas
9.8	7.0	—	Long Reef, Florida
4.4	3.2	1.3	off Gov't Cut, Miami, Florida

Remarks. Mörch (1853) first identified this relatively common West Indian species with *Venus purpurascens* of Gmelin. Gmelin (1791) listed three figures under *purpurascens*, of which Lister's (1685) plate 303, fig. 144 is identifiable with the species; it is here considered the type figure. The homonym *Amphidesma purpurascens* Lamarck is a mactrid and has been considered a synonym of *Ervilia nitens* (Montagu) while another homonym, *Amphidesma purpurascens* Sowerby from the Pacific coast of South America is a true *Semele* which has been renamed *S. sowerbyi* by Lamy (1912). *Amphidesma variegata* Lamarck is based on plate 291, fig. 3 of the Encyclopédie Méthodique and is here construed as the type figure; the locality given by Lamarck, namely "les côtes d'Afrique?" was questioned and is here corrected and restricted to Key West, Florida. The case for *Amphidesma laeta* is the same as that for numerous other species originally described in *Semele* by Adams for the Zoological Society in 1853 but not published until 1854, and therefore antedated by Reeve (1853). Dall (1900) questioned and cited *Semele formosum* "Sowerby" Krebs in

the synonymy of this species and it is included here for the sake of completeness; we do not know what Krebs' concept of *formosum* was. True *S. formosum* Sowerby is an eastern Pacific species (Olsson, 1961). Extensive historical synonymies of *S. purpurascens* were

and in St. Petersburg and Fort Thompson by Olsson and Harbison (1953). Guppy (1867; 1874) and Maury (1925) list it from the Pliocene formation at Matura, Trinidad. Gabb (1881) found it in the Pliocene clays of Costa Rica. Pleistocene records

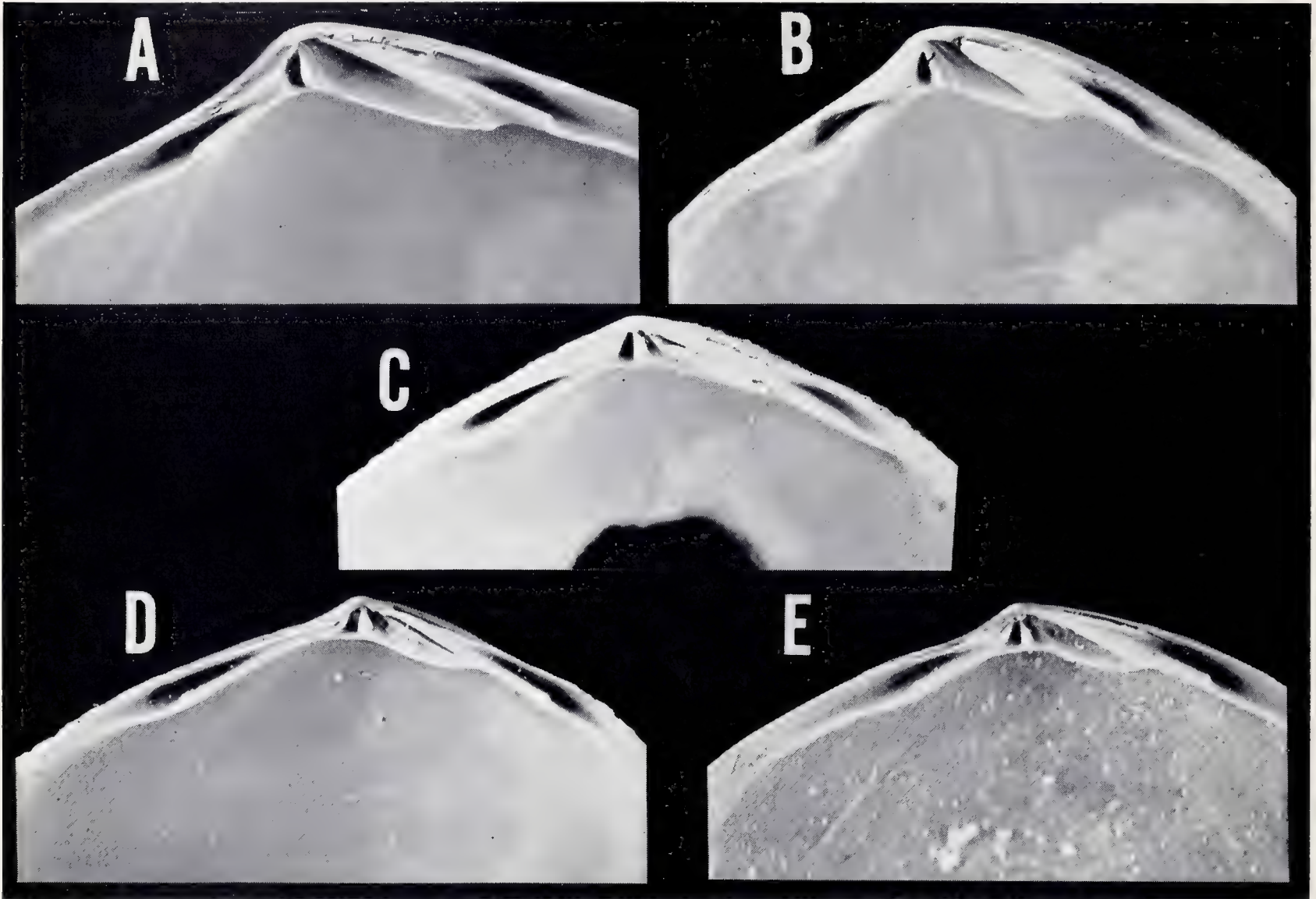


Plate 7. The configuration of the hinge line of the right valve in *Semele*. A—*Semele proficua*, USNM 441153, Port Maria, Jamaica (length 17.8 mm.); B—*Semele modesta*, MCZ 232214, Ascension Island (length 13.1 mm.); C—*Semele bellestriata*, USNM 604757, off Long Boat Pass, Florida (length 14.5 mm.); D—*Semele casali*, MCZ 258310, off Bermeja Head, Argentina (length 14.7 mm.); E—*Semele purpurascens*, USNM 53666, Key West, Florida (length 15.0 mm.).

given by Lamy (1914) and Weisbord (1964).

The fossil history of *S. purpurascens* begins in the upper Miocene of the Choctawhatchee formation, where Mansfield (1932) recorded its occurrence in the *Ecphora* zone at Jackson Bluff, Florida. In the Pliocene, the species has been found in the Caloosahatchie beds by Dall (1900)

include the coast limestone formation at Macoris, Santo Domingo (Gabb, 1873; Maury, 1917).

The eastern Pacific analog of *S. purpurascens* is *S. sparsilineata* Dall which occurs from Nicaragua to Ecuador (Hertlein and Strong, 1949; Olsson, 1961). According to Dall (1915), the number of oblique sulci is less in *S. sparsilineata* than in *S. purpurascens*.

Olsson (1961) noted that *S. sparsilineata* is usually smaller, heavier, and less convex than

S. purpurascens. Specimens from West Africa which have been referred to *S. pur-*

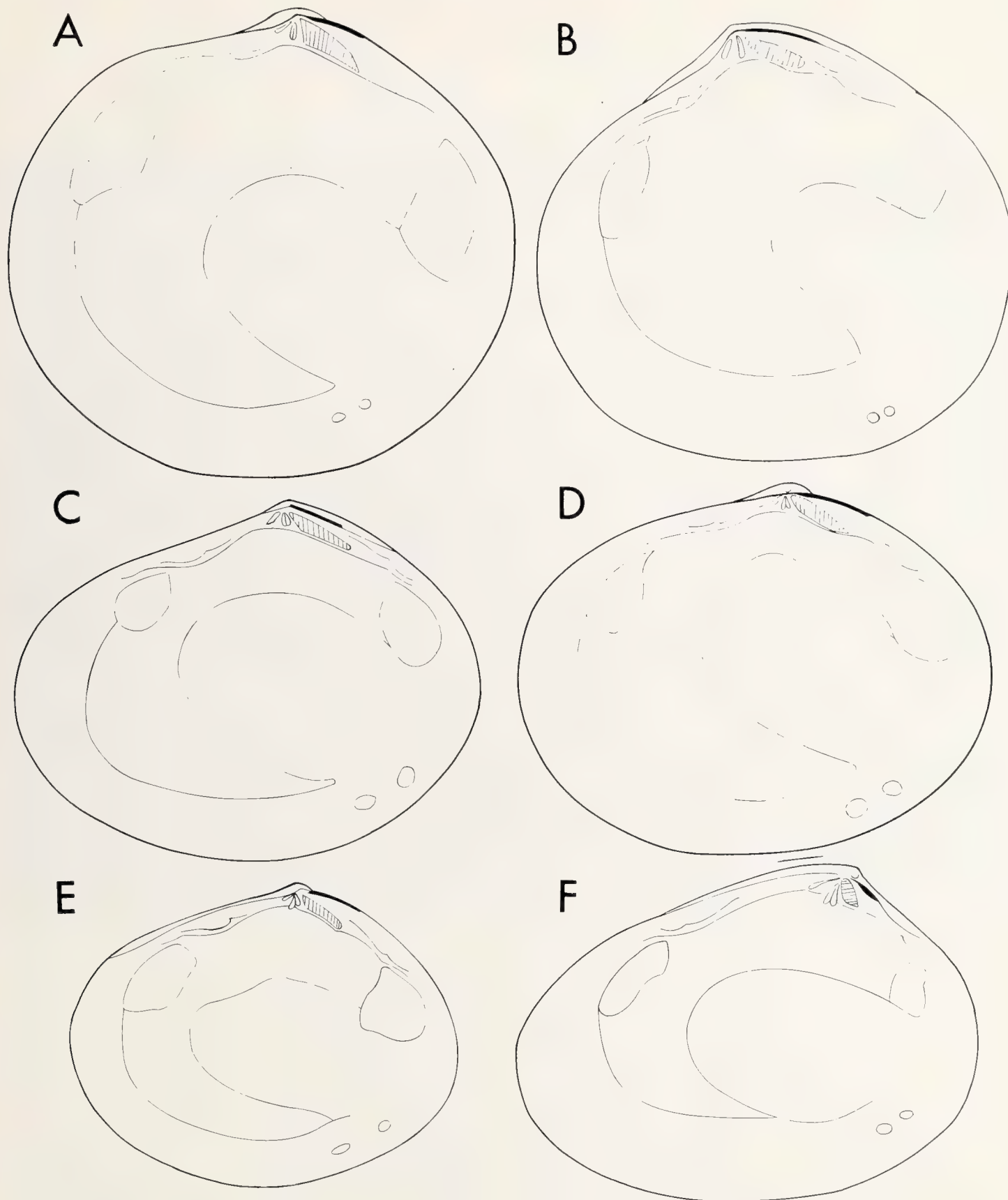


Plate 8. The configuration of the pallial sinus, dentition, and muscular scars of the right valve in *Semele*. A—*Semele proficua*, USNM 467958, Indian Pass, Apalachicola, Florida (length 22.5 mm.); B—*Semele modesta*, MCZ 232214, Ascension Island (length 21.4 mm.); C—*Semele casali*, MCZ 258310, off Bermeja Head, Argentina (length 21.0 mm.); D—*Semele purpurascens*, USNM 53666, Key West, Florida (length 21.4 mm.); E—*Semele bellestriata*, USNM 53662, Sarasota, Florida (length 17.8 mm.); F—*Semele nuculoides*, USNM 92143, off Cape Fear, North Carolina (length 4 mm.).

purascens by Lamy (1923)¹ and Nicklès (1947; 1950; 1952) belong to *S. lamyi* (Nicklès, 1955). The character of the pallial sinus, the strength of the cardinal dentition, and the nature of the sculpture are traits by which Nicklès has separated and contrasted *S. lamyi* and *S. purpurascens*.

S. purpurascens usually lives in shallow water and in sandy substrates although it has been taken alive at 350 fathoms off Pernambuco, Brazil, by the *Challenger* (Smith, 1885). Parker (1959) showed that it typically inhabits the shallow, grassy, and hypersaline bays along the Texas coast. Likewise, Geofferjé (1950) found it commonly in the shallow sandy beaches at Farol, Caiobá, and Caieiras, Parana, Brazil. McNulty *et al.* (1962) listed it as an infaunal element in Biscayne Bay, Florida, associated with a bottom type of coarse grain size (0.6 mm.).

Range. *S. purpurascens* occurs from Cape Fear, North Carolina to the Rio de la Plata, which separates Uruguay and Argentina. It is found along the coast of the Gulf of Mexico, including Texas (Singley, 1893; Pulley, 1952), Vera cruz, Mexico (Baker, 1891), and Campeche, Mexico (Weisbord, 1926). It occurs commonly along the coasts of South America, even in the Gulf of Paria (Guppy, 1877; 1894) and particularly in Brazil (Morretes, 1949; Gefferjé, 1950). The cited occurrence of *S. obliqua* Wood (= *purpurascens*) from Bermuda by Tristram (1861) is doubtful and contraindicated by Davis (1904) and Peile (1926) who did not record this species. Mansfield (1932) gave its southernmost range as Argentina. That record rests on a single dead valve, so it may be assumed that the species does not commonly occur south of Brazil.

Specimens examined. NORTH CAROLINA: *Albatross I* station 2622, 25 miles SE of Cape Fear (33°38'N, 77°36'W), in 15 fathoms; *Albatross I* station 2615, 27 miles ESE of Cape Fear (33°45'N, 77°25'W), in 18 fathoms; *Albatross I* station 2616, 25 miles ESE of Cape Fear (33°42'N, 77°31'W) in 17 fathoms; *Albatross I* station 2617, 25 miles SE of Cape Fear (33°37'N, 77°36'W),

in 14 fathoms; *Albatross I* station 2619, 25 miles ESE of Cape Fear (33°38'N, 77°36'W), in 15 fathoms (all USNM). FLORIDA: off Palm Beach, in 130 fathoms; Lakeworth; off Lantana, in 90 fathoms; Boynton (all MCZ); Fish Haven (USNM); Causeway, Biscayne Bay (MCZ); off Fowey Light, in 22-60 fathoms; off Government Cut, Miami, in 3-38 fathoms; off Miami, in 10-60 fathoms; off Long Reef, in 40 fathoms; off Conch Reef, in 35 fathoms (all USNM); Pirates Cove, Sugar Loaf Key, in 2 fathoms (MCZ); Key West (MCZ; USNM); SW of Garden Key, Dry Tortugas, in 63 fathoms (MCZ); Dry Tortugas (USNM); Caximba Pass (MCZ); Fort Myers (USNM); Punta Rassa (MCZ); Sanibel Island (USNM); 30 miles W of Sanibel (MCZ); Charlotte Harbor; Longboat Pass (both USNM); Tampa Bay (ANSP); 80 miles W of Tampa, in 38 fathoms (MCZ); Pass-a-grille (MCZ); Indian Rocks; Tarpon Springs; Egmont Key (all three USNM). TEXAS: St. Joseph's Island (MCZ). MEXICO: Veracruz (ANSP); Isla del Carmen (MCZ). BRITISH HONDURAS: ESE of Punta Negra (16°16'15"N; 88°32'10"W) (both ANSP); off Mullins River (17°06'15"N; 88°15'40"W). BERMUDA: Harrington Sound (ANSP). BAHAMA ISLANDS: N. Bimini Island, in 20 fathoms; Nassau, New Providence Island (both USNM); Great Oyster Pond, Eleuthera Island (MCZ). CUBA: *Barrera* stations 202 and 203, Cabanas Harbor, in 3-25 fathoms (USNM); Guantanamo Bay (MCZ). JAMAICA: Kingston (USNM); Port Royal (MCZ). HISPANIOLA: SANTO DOMINGO: Monte Cristi (MCZ). PUERTO RICO: Punta Guanajibo (MCZ). VIRGIN ISLANDS: Tortola (USNM); Anegada Island (ANSP); Monkey Point, Guana Island; St. Johns; St. Thomas (all MCZ). LESSER ANTILLES: Pigeon Point, Tobago (MCZ); Chaguaramas Bay, Trinidad (USNM); Saut d'Eau Bay, Trinidad, in 10-20 fathoms (MCZ); Aruba (ANSP). BRAZIL: Todos Santos Bay, Bahia (MCZ); Rio de Janeiro (USNM); Praia do Leste, Ilha Guaiba (MCZ); Vitoria (MCZ); São Sebastian, São Paulo (USNM); Nictheroy (MCZ). URUGUAY: *Albatross I* station 2765, off Rio de la Plata, in 10½ fathoms (USNM).

Semele bellestriata (Conrad)

Plate 6, figs. E, F; Plate 7, fig. C; Plate 8, fig. E; Plate 9; Plate 11, fig. A.

Amphidesma bellestriata Conrad 1837. Jour. Acad. Nat. Sci. Philadelphia, 7 (2): 239, pl. 20, fig. 4 (Mobile Point, Alabama; types not mentioned in Moore, 1962).

Amphidesma cancellata d'Orbigny 1842 [in] Sagra, Hist. L'Ile Cuba, Atlas, pl. 25, figs. 42-44; 1845, Spanish Text, 2: 297 (a las Antillas . . . Martinica y la Guadalupe); 1853, French Text, Mollusques, 2: 241 (aux Antilles . . . à la Guadeloupe et à la Martinique; types, BMNH).

Semele nexilis Gould 1862. Proc. Boston Soc. Nat. Hist., 8: 281 (inhabits Georgia; types missing, Johnson, 1964, p. 115).

Abra bella Conrad 1873 [in] Kerr, Report of the Geological Survey of North Carolina (1875), vol. 1,

Appendix A, p. 19, pl. 3, figs. 4, 6 (Wilmington, North Carolina [Miocene]; syntypes, ANSP 18818).

Semele lata Bush 1885. Trans. Conn. Acad., 6 (2): 476 (*nomen nudum*).

Semele bellestriata donovani McGinty 1955. Proc. Acad. Nat. Sci. Philadelphia, 107: 83, pl. 2, fig. 14 (off Peanut Id., near the North Inlet in Lake Worth, Florida, in 2 fathoms; holotype, McGinty Collection).

lation; anterior dorsal margin straight to somewhat concave; posterior dorsal margin more steeply descending, short, somewhat convex; posterior margin short and indistinct, giving outline of shell truncated appearance. Sculpture consisting of concentric ridges

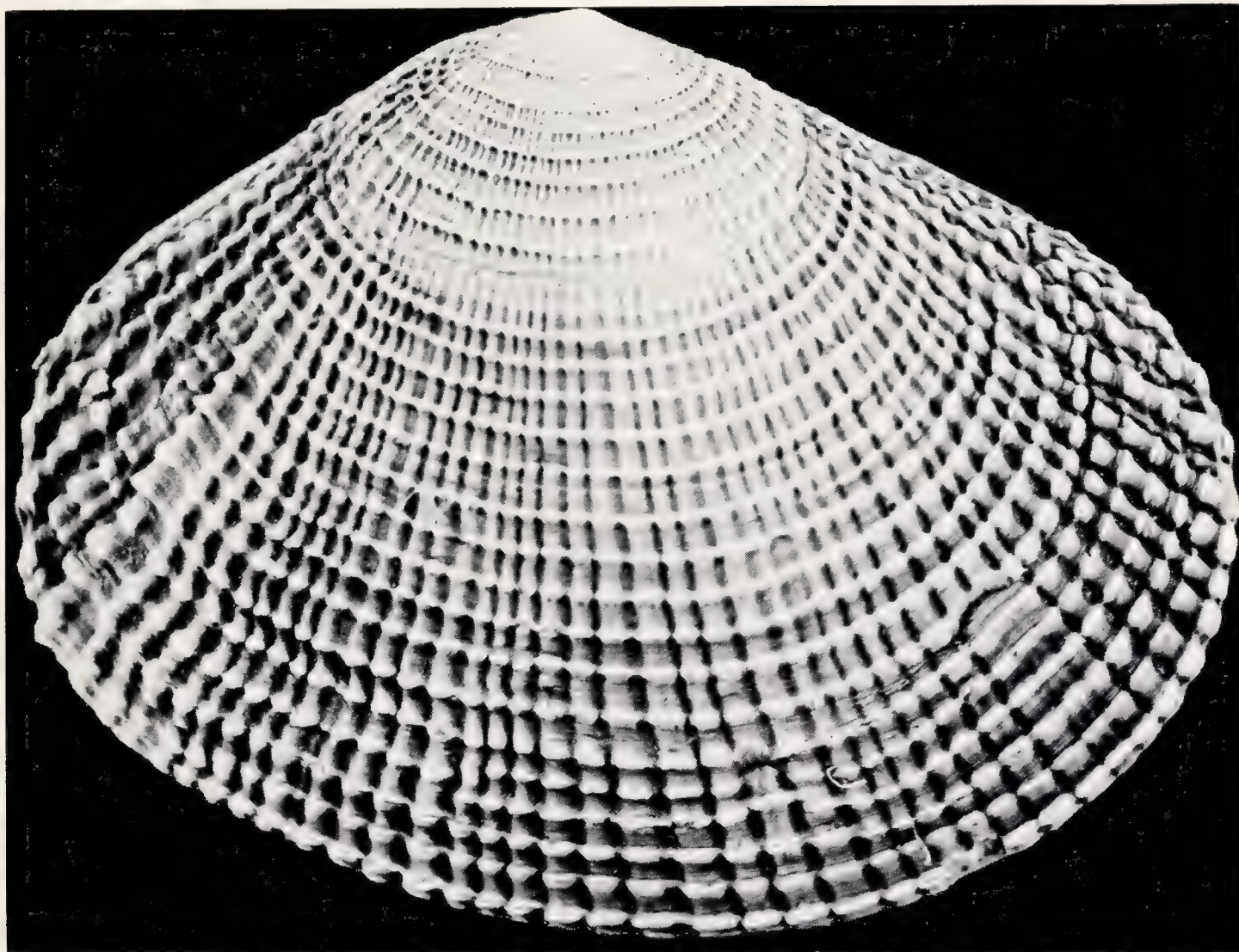


Plate 9. External view of the right valve of *Semele bellestriata*, USNM 604757, off Longboat Pass, Florida (length 12.4 mm.).

Description. Shell extending to 24 mm in length and to 19 mm in height, irregularly subrectangular, slightly inequilateral with anterior portion longer, solid, with both valves of more or less equal convexity and with strong flexure to right posteriorly. Umbos slightly behind middle, accentuated by anterior white radial streak, small, not elevated, and generally pointed; umbonal cavity shallow. Anterior margin narrowly to broadly rounded; ventral margin gently rounded, rising posteriorly at postbasal angu-

crossed by irregular radial riblets forming cancellate pattern. Radial riblets stronger along posterior dorsal slope in both valves; each radial riblet with fine concentric lirations. Weak anterior radial ridges in both valves; narrow areas not concentrically sculptured medial to ridges but separated from lunule. Two weak radial posterior ridges evident. Ligament consisting of two opisthodontic portions: external thin, undeveloped portion resting on flattened nymphs in poorly developed escutcheon; internal portion con-

sisting of short, narrow resilium resting in excavated chondrophore. Left cardinal complex of anterior narrowly bifid tooth and of posterior thin, laminate cardinal tooth closely adpressed to resilial portion of ligament. Anterior lateral tooth stronger and nearer to cardinal complex than posterior lateral tooth. Right cardinal complex consisting of anterior thickened laminate tooth adpressed to base of lunule and of posterior subdeltoid bifid tooth. Right anterior lateral tooth stronger and closer to cardinal complex than posterior lateral tooth. Left lateral dentition weaker than right. Anterior adductor muscle scar rounded ventrally, flattened dorsally, and larger than subquadrate posterior muscle scar. Pallial sinus rising gently posteriorly, linguiform, unequal in opposite valves, extending somewhat closer to anterior adductor muscle scar in right valve than in left. Color from white to almost purple. External suffusions of color concentrated radially or peripherally. Occasional central internal yellow suffusions.

length	height	width	
23.6 mm	18.5 mm	—	Seahorse Key, Cedar Keys, Florida
23.0	17.0	8.1 mm	Longboat Pass, Florida
19.1	15.3	7.2	Big Marco Pass, Florida
15.3	11.4	5.5	Tampa, Florida
12.3	9.5	4.1	Longboat Pass, Florida
4.0	2.7	1.2	Marco, Florida

Remarks. *Amphidesma cancellatum* was first used by Sowerby in his catalog of *Amphidesma* in the Conchological Illustrations of 1833, with the localities Antigua and St. Vincent but without a figure or description; the name, in this case, is a *nomen nudum*. He had planned to illustrate the species in the second volume of the Species Conchyliorum, which never appeared. Hanley finally published the plates of *Amphidesma* of the Species Conchyliorum in his Conchological Miscellany in 1857; however, Reeve (1853) had already figured *A. cancellata* without locality in the Conchologia Iconica. The accredited authority of *A. cancellata* is

d'Orbigny, who figured the species in 1842 and described it in 1845 and again in 1853. Since the name dates from 1842, we can not subscribe to the taxonomic treatment accorded the species by Lamy (1914) who used *cancellata* as a senior synonym of *bellestriata*. Since *cancellata* dates from 1842 and *bellestriata* from 1837, we are obliged, under the laws of priority, to retain *bellestriata*.

Semele lata Bush is also a *nomen nudum*, one which Bush attributed to C. B. Adams on the basis of what was possibly a manuscript name of Adams in the Yale collection. Specimens similarly named are in the USNM, but Adams never described a species under this appellation (see Clench and Turner, 1950). A *Semele laeta* (A. Adams) Reeve has been described and is treated in the synonymy of *S. purpurascens*.

The fossil history of *S. bellestriata* is well documented in North America. The species occurs in the Miocene at Wilmington, North Carolina (Conrad, 1873) and in the *Ecphora* zone of the lower upper Miocene at Jackson Bluff, Florida (Mansfield, 1932). In the Pliocene, the species has been found at numerous localities in the Waccamaw formation of North and South Carolina (Gardner, 1943), along the Caloosahatchie River and Shell Creek, Florida (Dall, 1900), and at St. Petersburg, Florida (Olsson and Harbison, 1953). Maury (1920) gave a Pleistocene locality in New Orleans.

From all other species of *Semele* in the western Atlantic, *S. bellestriata* may be distinguished by its sculpture alone. It is the only species which possesses strongly cancellate sculpture. In many specimens the area which separates the anterior laminate cardinal tooth and the anterior lateral tooth is colored deep purple. The margin of the shells may be somewhat crenulated ventrally. An allopatric growth pattern is evident: large adults are noticeably less strongly sculptured and more rounded and higher than immature forms.

Semele pacifica Dall which ranges from Catalina Island, California, to Panama is the eastern Pacific analog of *S. bellestriata* (Hertlein and Strong, 1949; Olsson, 1961).

Range. *Semele bellestriata* occurs from off Cape Hatteras south through the Antilles and Bahamas to about 100 miles northeast of Bahia, Brazil where Rios and Cardoso (1967) have recorded it at Jaraguá, Alagoas, Brazil ($9^{\circ}41'S$; $35^{\circ}43'W$). It is found along the west coast of Florida and to the Mississippi Delta (Vanatta, 1903; Parker, 1956), but not along the Gulf coast of Texas or Mexico. In northern South America it has been taken in Colombia and Venezuela (Dautzenberg, 1900). The species seems to prefer coarse sandy substrates in which it lives buried as a member of the infauna. Robertson (1960) showed that in the Bahamas it is found in the *Thalassia* zone. The species normally lives offshore in moderate depths between 4 and 50 fathoms. Specimens have been recovered from 130 fathoms, and Abbott (1958) reported dead valves of small individuals in shallow depths of 6-16 feet (2-5 m) at Grand Cayman. Off Conch Key it has been taken in 1-5 feet (.3-1.5 m).

Specimens examined. NORTH CAROLINA: *Albatross I* station 2290, off Cape Hatteras ($35^{\circ}23'00"N$, $75^{\circ}25'30"W$) in $9\frac{3}{4}$ fathoms; *Albatross I* station 2596, off Cape Hatteras ($35^{\circ}08'30"N$, $75^{\circ}10'00"W$), in 49 fathoms; *Albatross I* station 2597, off Cape Hatteras ($34^{\circ}57'00"N$, $75^{\circ}43'30"W$), in 15 fathoms; *Albatross I* station 2598, off Cape Hatteras ($34^{\circ}51'00"N$, $75^{\circ}40'15"W$), in 22 fathoms; *Albatross I* station 2607, off Cape Hatteras ($34^{\circ}38'00"N$, $76^{\circ}12'00"W$), in 18 fathoms (all USNM); Shackleford Island (MCZ); Beaufort, in 6-9 fathoms; *Albatross I* station 2615, off Cape Fear ($33^{\circ}45'00"N$, $77^{\circ}25'00"W$), in 18 fathoms; *Albatross I* station 2616, off Cape Fear ($33^{\circ}42'45"N$, $77^{\circ}31'00"W$), in 17 fathoms; *Albatross I* station 2619, off Cape Fear ($33^{\circ}38'00"N$, $77^{\circ}36'00"W$), in 15 fathoms; *Albatross I* station 2617, off Cape Fear ($33^{\circ}37'30"N$, $77^{\circ}36'30"W$), in 14 fathoms; Frying Pan Shoals, in $12\frac{1}{2}$ fathoms (all USNM). FLORIDA: off Breaker's Hotel, Palm Beach, in 50 fathoms; off Palm Beach, in 130 fathoms (both MCZ); off Lantana, in 70 fathoms; off Miami Beach, in 8-60 fathoms; off Bear's Cut, in 18-30 fathoms; off Government Cut, Miami, in 3-65 fathoms; off Fowey Light, in 6-80 fathoms; off Long Reef, in 4 fathoms; off Turtle Harbor, in 40-50 fathoms; off Conch Key, in 1-5 feet (all USNM); Pirate's Cove,

Sugarloaf Key, in 2 fathoms (MCZ); off Smith Shoal, Key West, in 5-50 fathoms; off Sand Key, in 30-100 fathoms; Boca Grande Key; Dry Tortugas, in 15 fathoms; Cape Romano; Caximba Pass; off Marco, in 2 fathoms; Big Marco Pass; *Albatross I* station 2410, off Sanibel Island ($26^{\circ}47'30"N$, $83^{\circ}25'15"W$), in 28 fathoms (all USNM); 30-40 miles W of Sanibel Island, in 19 fathoms; Captiva Island; Charlotte Harbor; Sarasota Bay (all MCZ); *Albatross I* station 2409, off Sarasota ($27^{\circ}04'00"N$, $83^{\circ}21'15"W$), in 26 fathoms; Longboat Pass; Point Pinellas; Tampa; *Fish Hawk* station 7106, off Anclote Light, in $21\frac{1}{2}$ fathoms; *Albatross I* station 2405, W of Anclote Keys ($28^{\circ}45'00"N$, $85^{\circ}02'00"W$), in 26 fathoms; *Albatross I* station 2406, W of Anclote Keys ($28^{\circ}46'00"N$, $84^{\circ}49'00"W$), in 26 fathoms; Sea Horse Key, Cedar Keys (all USNM); off Destin, in 14 fathoms (MCZ); Fort Walton, in 14 fathoms (USNM). MISSISSIPPI: Horn Island (ANSP). MEXICO: Isla Contoy and Isla Mujeres, Yucatan (both MCZ). BRITISH HONDURAS: E. of Congreja Cay ($17^{\circ}15'05"N$, $87^{\circ}58'30"W$) in 12 feet; S. of Pompian Cay ($16^{\circ}21'45"N$, $88^{\circ}06'50"W$) in 29 feet (both ANSP). BERMUDA: Hamilton (ANSP); Castle Roads, Castle Harbor; North Rock; Bailey's Bay (all MCZ). BAHAMA ISLANDS: Moraine Cay, Little Abaco; Whale Cay Channel, Great Abaco, in 17 fathoms (both MCZ); North Bimini, in 20 fathoms; South Bimini; South Cat Cay (all USNM); Dick's Point, Old Fort, and Charlottesvill Bay, New Providence; Mangrove Cay, Andros; Orange Creek, Cat Island (all MCZ). CUBA: Cape Cajon; Arroyos; Bahia Honda, in 1-22 fathoms; Cabanas Harbor, in 25 fathoms; Cayo Levisa (all USNM); Habana; Pueblo Nuevo, Matanzas Bay (both MCZ). PUERTO RICO: Mayaguez, in 30 fathoms. VIRGIN ISLANDS: Anegada Island (ANSP); Devil's Bay, Virgin Gorda (MCZ). LESSER ANTILLES: English Harbor and Falmouth Antigua (both USNM); Grand Anse Beach and W. of Fort George, Grenada (both ANSP). CARIBBEAN ISLANDS: between Old Isaacs and Gorling Bluff, Grand Cayman; between Barker's Cay and Main Channel, North Bay, Grand Cayman (both MCZ). BRAZIL: *Albatross I* station 2758, 34 miles SE of Natal ($06^{\circ}59'30"S$, $34^{\circ}47'00"W$), in 20 fathoms (USNM). *Hassler station* ($11^{\circ}49'S$, $37^{\circ}27'W$) about 100 mi. NE of Bahia, in 12-17 fathoms (MCZ).

Semele casali Doello-Jurado

Plate 4, figs. C, D; Plate 5, fig. C; Plate 7, fig. D; Plate 8, fig. C; Plate 10, fig. D.

Abra uruguayensis 'Pilsbry' von Ihering 1907. Les Mollusques Fossiles . . . l'Argentine. Anales Museo Nacional Buenos Aires, ser. 3, 7: 423, *non* Pilsbry 1897.

Semele casali (Doello-Jurado MS) Carcelles 1944. Catalogo de los Moluscos Marinos de Puerto Quequén. Revista del Museo de La Plata (n.s.), Zoologia, 3: 281, *nomen nudum*.

Semele casali Doello-Jurado 1949. Comunicaciones zoológicas del Museo de Historia Natural de Montevideo, 3 (57): 1-4, figs. 1-2 (Golfo de San Matias; holotype,

Museo Argentino de Ciencias Naturales "Bernardino Rivadavia," no. 21287).

Semele casali Doello-Jurado. Barattini and Ureta. 1960. La Fauna de las Costas Uruguayas del Este. Concejo Dept. de Montevideo, p. 164.

Description. Shell extending to 24 mm in length and to 19 mm in height, elongate-ovate, inequilateral, equivalve, subsolid, moderately compressed with right valve of

vex, producing slight pointedness to outline of shell. Concentric sculpture consisting of regular sulci (about 5-6 per mm) separated by raised and rounded riblets or lirations distributed uniformly over surface of valves; no radial sculpture. Weakly defined radial ridge on posterior slope of right valve; concomitant sulcus on left. Ligament opisthodont-

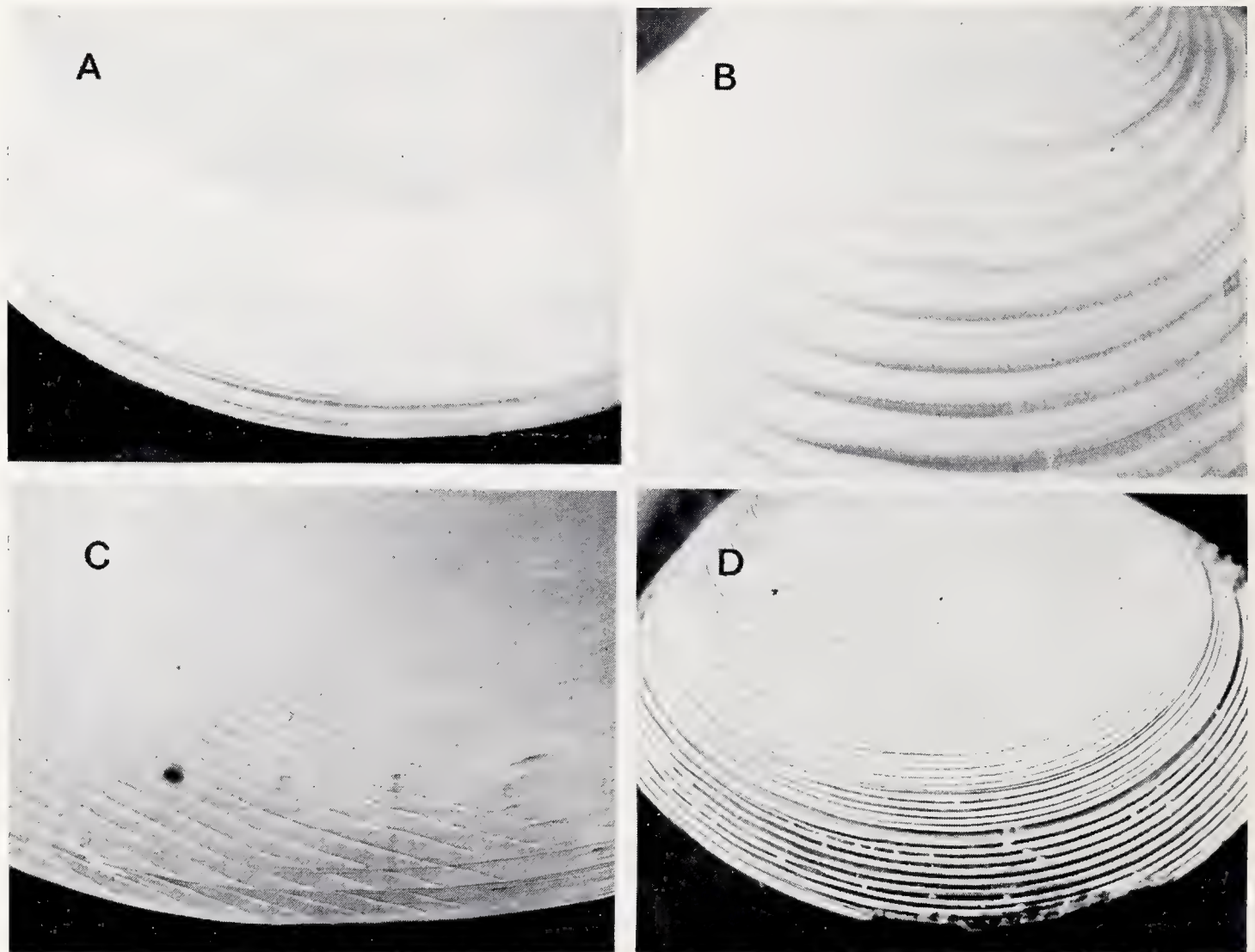


Plate 10. Characteristic sculpture on external surface of valves. A—*Semele proficua*, USNM 440798, Green Island Harbour, Jamaica; B—*Semele modesta*, MCZ 232 214, Ascension Island; C—*Semele purpurascens*, USNM 53666, Key West, Florida; D—*Semele casali*, USNM 17 0212, off Rio de la Plata.

greater convexity than left, and with slight flexure to left posteriorly. Umbos well behind middle, rather conspicuous and elevated. Anterior margin narrowly rounded; ventral margin gently convex and rising posteriorly; posterior dorsal margin short, convex, and descending obliquely; anterior dorsal margin long, more or less straight, and gently descending; posterior margin short, weakly con-

ic, consisting of internal oblique resilium in elongate chondrophore and of obsolete, elongate, thin, external portion. Escutcheon poorly developed, not impressed, narrow, elongate, and lanceolate; lunule subequal, impressed, subcordiform, more extensive in right valve, and generally colored red or red-orange. Hinge line well developed. Left cardinal complex consisting of subtrigonal,

thickened, sometimes slightly bifid anterior cardinal tooth, often broken or closely adpressed to anterior portion of resilium. Left lateral teeth weakly pointed, moderately well developed, and shelf-like; anterior lateral tooth slightly more distally removed from umbo than posterior lateral tooth. Right cardinal complex consisting of, thickened laminate, anterior cardinal tooth (often coalesced with base of lunule) and of subtrigonal, bifid, posterior cardinal tooth. Right lateral teeth well developed, socketed above, thickened, pointed, and upcurled; posterior lateral tooth slightly more distal to umbo than anterior lateral tooth. Muscle scars poorly impressed; internal surface of valve polished; posterior adductor muscle scar subquadrate; anterior adductor scar irregularly sublunate. Pallial sinus broad, equal in both valves, rising sharply and obliquely behind and rounded broadly in front. Externally, shell whitish with indications of yellowish or reddish-orange; internally, central suffusions of yellow or reddish-orange; lunular area with concentrations of red.

length	height	width	
23.3 mm	18.5 mm	9.8 mm	holotype of <i>casali</i> Doello-Jurado
23.8	18.2	—	off Punta Bermeja, Argentina
21.0	15.8	6.8	off Rio de la Plata, Uruguay
19.6	14.3	6.7	off Rio de la Plata, Uruguay
15.1	10.7	4.9	off Punta Bermeja, Argentina
9.3	6.8	2.9	off Punta Norte, Argentina

Remarks. Von Ihering (1907) first noted the existence of this species but erroneously referred it to "*Abra uruguayensis* Pilsbry." He also documented its occurrence in the fossil record of the Postpampean of Puerto Militar as well as in the recent fauna of Argentina. Evidently, Doello-Jurado had detected this misidentification by 1944 and assigned the name *Semele casali* to the species, for it was so used as a Doello-

Jurado manuscript name without a description in the Puerto Quequén catalog by Carcelles (1944). The Doello-Jurado species was fully described and formally named posthumously in 1949 from manuscripts in the museum archives.

Semele casali is immediately preceded in the fossil record by the "*Abra patagonica*" of von Ihering (1907), which is found in the lower Patagonian of Camarones and which is truly a *Semele*. Doello-Jurado (1949), who had access to the specimens of von Ihering, explained how *S. patagonica* differs from *S. casali*.

Semele casali is distinguished from other species of *Semele* in the western Atlantic by its elongate shape, distinctive lirate sculpture, and broad, extensive pallial sinus. The lunular area may be diagnostic in the presence of a concentration of reddish coloration.

Range. This species, evidently not well represented in North American collections, occurs from southern Brazil to the Golfo San Matias, Argentina, and therefore exhibits a restricted southern temperate distribution. Doello-Jurado (1949) listed six separate localities, and Carcelles (1944) stated that the species prefers a habitat of sand in the deep sublittoral zone. It lives in depths as great as 30 fathoms (55 m). The record, published as 33°24'S, 53°47'W, by Doello-Jurado (1949), is erroneous because this locality is in inland Uruguay. The documented distribution of *S. casali* is from off Carapebus, Espirito Santo, north of Rio de Janeiro, Brazil (based on a single right valve) to the Golfo San Matias, Argentina.

*Specimens examined.*¹ BRAZIL: Carapebus, Espirito Santo (ANSP); Cabo dois Irmãos, 23°00'S, 43°14'W (USNM). URUGUAY: *Albatross I* stations 2764 and 2765, off Rio de la Plata, in 10½ to 12 fathoms (both USNM). ARGENTINA: Hassler stations, 41°17'S, 63°00'W, in 17 fathoms, off Punta Bermeja, and 41°40'S, 63°13'W, in 30 fathoms, off Punta Norte, Golfo San Matias (both MCZ).

¹Recently, a specimen of a species of *Semele*, which I here tentatively refer to *S. casali* and which considerably extends the range of the species northward, was

dredged in 22.2 m at *Snellius II* Sta. m 84, 6°19.6'N, 54°04.5'W, NW of the Maroni River, Suriname. The specimen, having a slightly heavier, more distinct sculpture than typical *casali*, is in the Rijksmuseum van Natuurlijke Historie, Leiden, Holland and was kindly forwarded to me by Dr. Hanneke Nijssen-Meyer.

Subgenus *Semelina* Dall

Semelina Dall 1900. Trans. Wagner Free Inst. Sci. Philadelphia, 3(5): 986 (type-species by original designation *Amphidesma nukuloides* Conrad 1841).

subsequently treated at the generic and sub-generic levels. Since the differences which characterize *Semelina* are largely those due to the consequences of reduced size, as suggested by Dall, they are scarcely deserving of generic significance.

Semelina has been a distinct element in the fauna of North America since lower Miocene

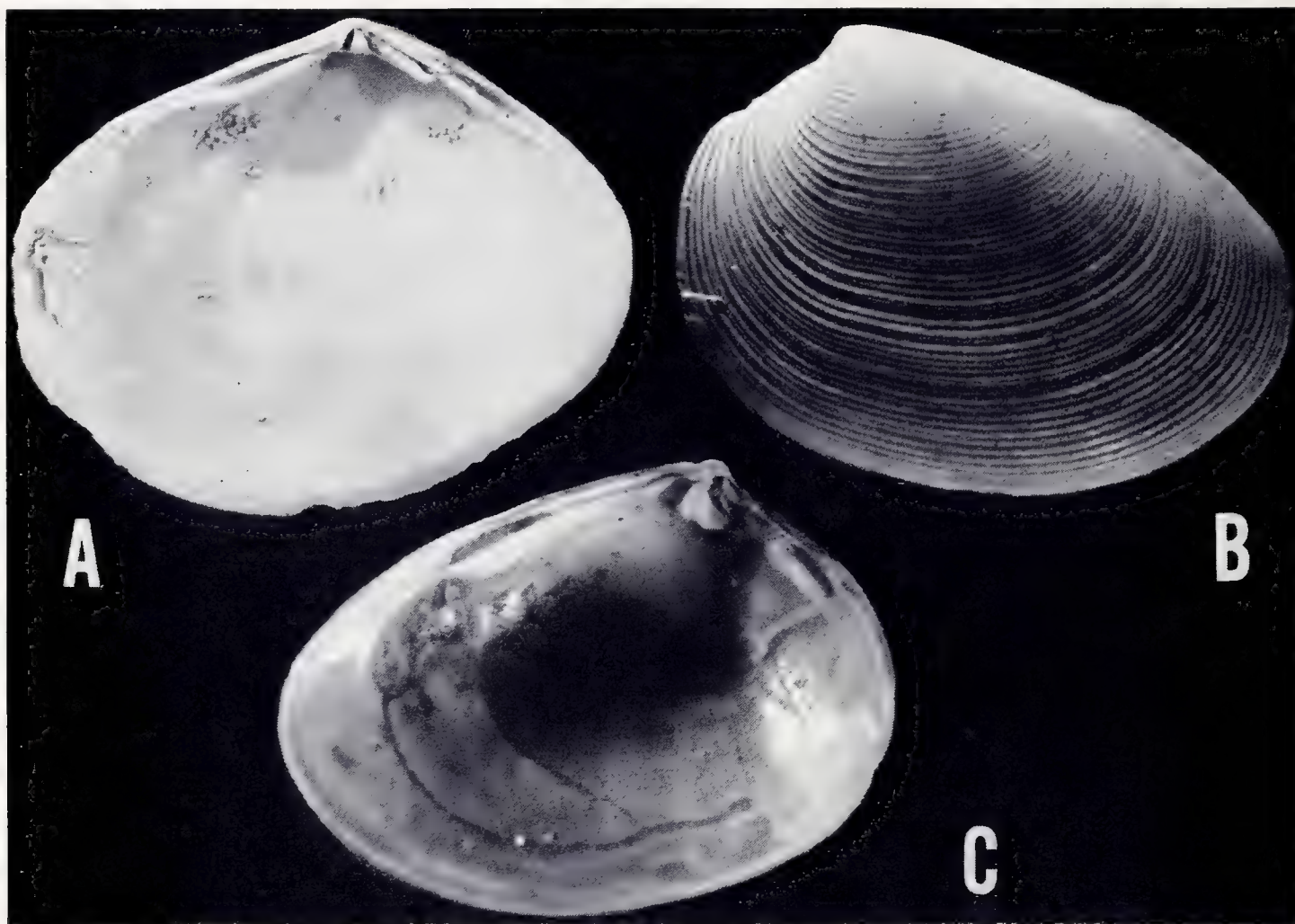


Plate 11. A—Internal view of the right valve of *Semele bellestriata*, USNM 152744, Big Marco Pass, Florida (length 19.3 mm.); B—external view of the right valve of *Semele nukuloides*, USNM 438407, Barrera station 202, Cabanas Harbor, Cuba (length 3.7 mm.); C—internal view of the right valve of *Semele nukuloides*, USNM 1611773, off San Juan, Puerto Rico (length 4 mm.).

This group of semelids is typified by their small size and nukuliform shell. The sculpture consists of strong, regular, concentric lirations or riblets. The lateral teeth of the right valve are very strong and well developed while the lateral dentition of the left valve is obsolete or absent. The shell is inequilateral and rather solid.

The group, originally introduced as a section of the genus *Semele* by Dall, has been

times. It is represented in the modern faunas of both the Western Atlantic and the Eastern Pacific.

Semele (Semelina) nukuloides (Conrad)

Plate 8, fig. F; Plate 11, figs. B, C; Plate 12, fig. E.

Amphidesma nukuloides Conrad 1841. Amer. Jour. Sci., 1st ser., 41: 347; 1845, Fossils Medial Tertiary, p. 73, pl. 41, fig. 6 (Wilmington, North Carolina [Pliocene]; type, lost, *teste*, Moore, 1962, p. 80).

Abra nukuloides (Conrad), 1863. Proc. Acad. Nat. Sci. Philadelphia, 14: 574.

Semele nuculoides (Conrad). Dall 1889. Bull. U. S. Nat. Mus., No. 37, p. 62.

Semele (*Semelina*) *nuculoidea* (Conrad). Dall 1900. Trans. Wagner Free Inst. Sci. Philadelphia, 3(5): 994 (error for *nuculoides* Conrad).

Semele (*Semelina*) *nuculoides lirulata* Dall 1900. Trans. Wagner Free Inst. Sci. Philadelphia, 3(5): 994; no type designated; type locality not given.

Semelina nuculoides (Conrad). Olsson and Harbison 1953. Acad. Nat. Sci. Philadelphia, Monogr. No. 8, p. 134.

Description. Shell extending to 6 mm in length and to 4 mm in height, elongate-nuculiform, greatly inequilateral, equivalve, solid, with each valve moderately convex and with slight flexure to right posteriorly. Umbo far behind middle, opisthogyrous, pointed, and rather conspicuous. Anterior margin smoothly and narrowly rounded; ventral margin slightly convex and rising gently posteriorly; anterior dorsal margin very long, gently descending, and slightly convex; posterior dorsal margin short, steeply descending and somewhat concave; posterior margin short, slightly convex and forming weakly defined, broad posterior truncation. Concentric sculpture consisting of fine, regular, raised lirations, becoming strong along posterior dorsal slope; radial sculpture obsolete. External ligament small, light brown, inconspicuous and set in cordiform escutcheon; lunule poorly developed, elongate, lanceolate; internal resilium small, inconspicuous, and subtrigonal. Hinge line well developed with strong dentition. In left valve, cardinal complex consisting of anterior, arcuate, elongate bifid tooth and of single laminate tooth subtending internal resilium; anterior lateral tooth shelf-like, elongate, distal, arcuate and obsolete; posterior lateral tooth stronger, shorter, subproximal. In the right valve, cardinal complex consisting of posterior narrow bifid tooth with subequal lobes and of anterior thin, single, arcuate, elongate, laminate tooth; anterior lateral tooth distal, strong, socketed above; posterior lateral tooth subproximal, strong, socketed above, but not as greatly developed as anterior lateral tooth. Lateral dentition much

stronger in right valve. Muscle scars not well impressed. Posterior adductor muscle scar subquadrate; anterior adductor muscle elongate. Pallial sinus large, high, extending close to the anterior adductor muscle scar and coalescent with the pallial line terminal. Shell generally white, infrequently rose or lemon.

length	height	width	
5.5 mm	3.7 mm		off Frying Pan Shoals, North Carolina
5.3	3.4	2.0 mm	off Frying Pan Shoals, North Carolina
4.1	2.9	1.4	Cabanas Harbor, Cuba
3.7	2.7	1.5	Cabanas Harbor, Cuba
3.6	2.3	1.3	off Frying Pan Shoals, North Carolina

Remarks. According to Moore (1962), the type of *Amphidesma nuculoides* Conrad is missing, and it may be considered lost; the original figure is poor but there are no species with which it might be confused. Conrad apparently had only a left valve upon which to base his description. The type came from Wilmington, North Carolina, in the Waccamaw formation of lower Pliocene age.

Specimens which possess faint radial striations occur infrequently in recent populations of *nuculoides*. To distinguish these specimens, Dall (1900) introduced the varietal name *lirulata*, which is here considered a synonym. The radial striations are only a variable characteristic of the species much as the occurrence of rose or lemon colored specimens reflect rare variations in the usual whiteness of the shell.

Syndosyma nuculoides (Conrad), cited and figured by Whitfield (1894, pl. 15, figs. 7-9), does not represent *nuculoides* and is apparently an erycinid, which Dall (1900) relegated to the *Fabella* section of *Sportella*.

The fossil history of *S. S. nuculoides* in the Tertiary deposits of North America and the Caribbean is well documented. Two precursors in its lineage, *S. S. striulata* Dall and *S. S. cythereoidea* Dall, are, respectively, from the Oak Grove sand and from the Chipola River formation of the Alum Bluff

group of Florida and are of lower and middle Miocene age (Dall, 1900; Gardner,

1928; Cooke, Gardner, and Woodring, 1943). The *nuculoides* element appears in

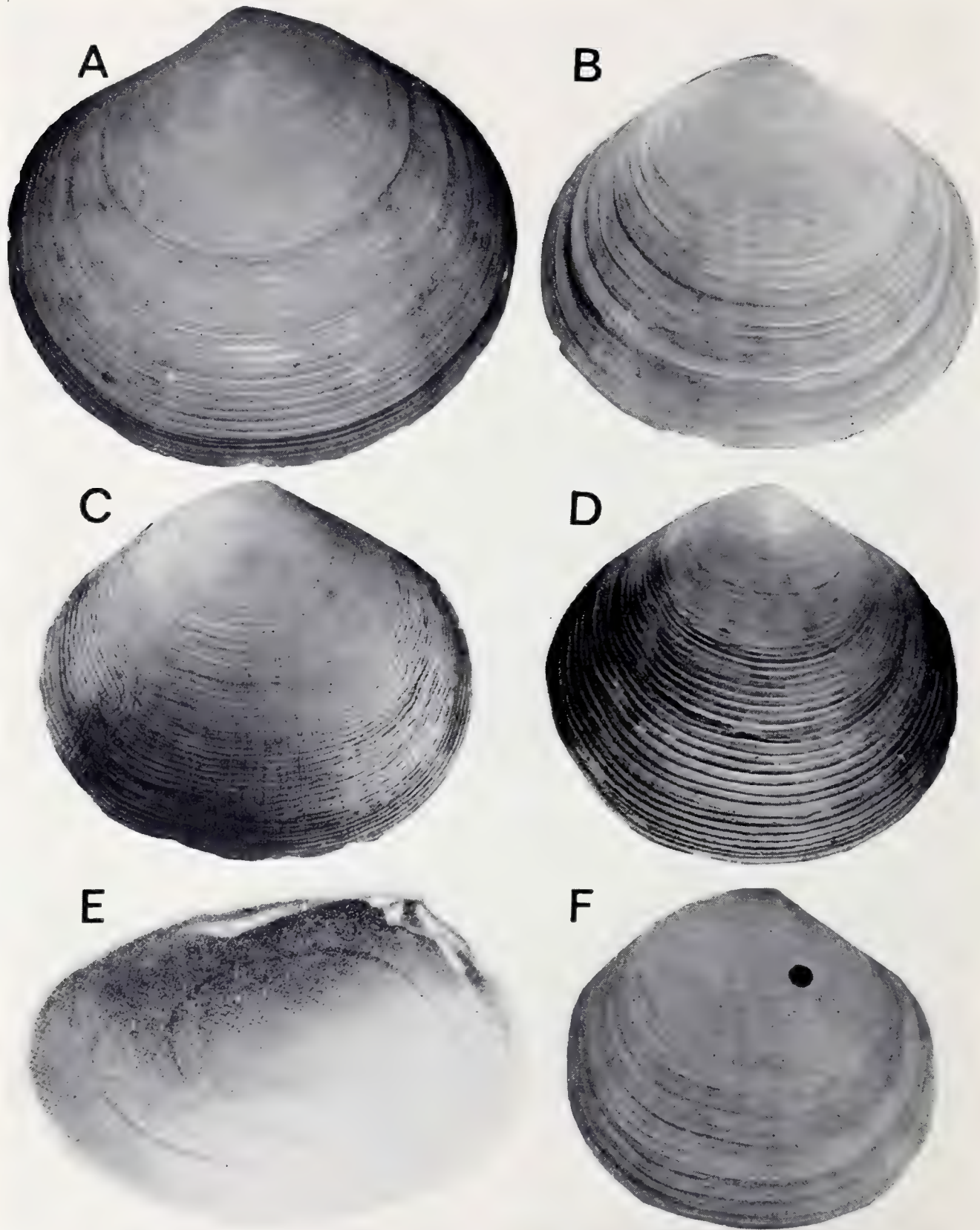


Plate 12. A—External view of the left valve of *Semele proficua*, USNM 441153, Port Maria, Jamaica (length 31.8 mm.); B—external view of the right valve of *Semele proficua*, USNM 94472, Bermuda (length 24.2 mm.); C—external view of the right valve of *Semele proficua*, USNM 467036, Grand Lake, Louisiana (length 27.2 mm.); D—external view of the right valve of *Semele proficua*, USNM 44971, Jamaica (length 34.4 mm.); E—internal view of the right valve of *Semele nuculoides*, USNM 325581, Neills Eddy Landing, Cape Fear River, North Carolina (length 5.6 mm.), reproduced from Gardner, 1943, pl. 17, fig. 20; F—external view of the right valve of *Semele proficua*, USNM 83350, Bermuda (length 23.5 mm.).

the middle and upper Miocene of the Choctawhatchee formation of Florida, the Yorktown formation in Virginia, and the Duplin marl of North Carolina (Dall, 1900; Mansfield, 1932; Gardner, 1943). In the Pliocene, *nuculoides* has been recorded from the Waccamaw formation in North and South Carolina, the Caloosahatchee marl of Florida, and the Playa Grande formation of Venezuela (Conrad, 1841; Dall, 1900; Mansfield, 1932; Gardner, 1943; Olsson and Harbison, 1953; Weisbord, 1964). In the Pleistocene, it has been discovered at 1200 feet at the Gymnasium Club Well, New Orleans, Louisiana, by Maury (1920). As is often the case, the recent specimens are generally smaller than the fossil ones.

Semele (*Semelina*) *clappi* Mansfield (1932) from the upper Miocene Choctawhatchee formation near Clarksville, Calhoun County, Florida, is a distinct relative of *nuculoides* which apparently died out before the Pliocene; it is peculiar because of its sharply subtrigonal shell.

In the fauna of the Western Atlantic, small specimens of *Tellina* (*Acorylus*) *gouldii* Hanley, because of their similar outline, might be confused with *nuculoides*. *Tellina* may be easily separated from *Semele* by its lack of an internal resilium. Furthermore, *gouldii* has a smooth external surface while *nuculoides* possesses rather strong concentric lirations.

The eastern Pacific analog of *nuculoides* is *Semele* (*Semelina*) *subquadrata* (Carpenter) which is distributed from Mexico to Colombia (Olsson, 1961).

Range. *Semele* (*Semelina*) *nuculoides* has a geological range from the Miocene to the Recent. Dall (1889) first recorded the species in the recent fauna; its zoogeographic range was at that time from Cape Hatteras, North Carolina to Tampa, Florida. The geographic range was extended first to include the Antilles (Dall and Simpson, 1901) and later to encompass the Brazilian coast of South America (Lamy,

1915; Morretes, 1940 and 1949) and the Caribbean coast of Panama (Olsson and McGinty, 1958). This species occurs from off Cape Hatteras, North Carolina, south through the Gulf of Mexico, the Lesser Antilles, the Caribbean Sea to Brazil. Specimens have been found in depths exceeding 100 fathoms, but the species is more typical of the offshore sandy substrates in 2 to 100 fathoms (4-183 m).

Specimens examined. NORTH CAROLINA: *Albatross I* stations 2272, 2597, 2610, off Cape Hatteras, in 15-22 fathoms; *Albatross I* stations 2607, 2608, 2611, 2612, off Cape Lookout, in 18-52 fathoms; *Albatross I* stations 2619, 2617, 2622, 2615, off Cape Fear, in 14-18 fathoms; off Frying Pan Shoals (all USNM). FLORIDA: *Eolis* stations 127, 129, 142, 155, off Fowey Light, in 40-48 fathoms; *Eolis* station 94, off Government Cut, Miami, in 42 fathoms; *Eolis* stations 324, 325, 337, off Sand Key, in 90-100 fathoms; *Eolis* stations 30, 102, 335, off Key West, in 7-10 fathoms (all USNM); Sanibel Island (MCZ); Tampa, in 3 fathoms; *Fish Hawk* station 7106, off Anclote Key, in 12 fathoms; Point Pinellas; Pensacola (all USNM). TEXAS: Heald Bank, off Galveston, in 45 feet (MCZ). COSTA RICA: Port Limon (USNM). CUBA: *Barrera* station 202, Cabanas Harbor, in 25 fathoms; *Barrera* station 203, Cabanas Harbor, in 3-12 fathoms; *Barrera* station 208, Bahia Honda, in 1-12 fathoms (all USNM). Pueblo Nuevo, Matanzas Bay, Matanzas (MCZ). PUERTO RICO: *Albatross I* station 6050, San Juan Harbor, in 7 fathoms; *Albatross I* station 6062, Mayaguez, in 30 fathoms (both USNM). LESSER ANTILLES: Falmouth and English Harbor, Antigua; Barbados (all USNM). PANAMA: Bocas, Colon (Olsson and McGinty, 1958). BRAZIL: Bahia (Lamy, 1915); Ilha de São Sebastian, Estado de São Paulo (Morretes, 1949).

LITERATURE CITED

- Abbott, R. T. 1958. The marine mollusks of Grand Cayman Island, British West Indies. Acad. Nat. Sci. Philadelphia, Monograph 11, 138 pp., 5 pls.
- Adams, A. C. and W. C. Kendall. 1891. Report upon an investigation of the fishing grounds off the west coast of Florida. Bull. U. S. Fish Comm. [1889], 9: 289-312, pl. 109.
- Aguayo, C. G. 1938. Moluscos Pleistocénicos de Guantánamo Cuba. Mem. Soc. Cubana Hist. Nat., 12: 97-118, pl. 14.
- Aldrich, T. H. 1921. New Eocene species from Alabama. Bull. Amer. Paleo., 9(37): 1-32, 3 pls.
- Atkins, D. 1937. On the ciliary mechanisms and interrelationships of lamellibranchs. Pt. 3. Quart. Jour. Micro. Sci., 79: 375-421.
- Baker, F. C. 1891. Notes on a collection of shells from southern Mexico. Proc. Acad. Nat. Sci. Philadelphia, 43: 45-55.
- Barrois, T. 1885. Les glandes du pied et les pores

- aquifères chez les lamellibranches. Danel, Lille, 169 pp.
- Bøggild, O. B. 1930. The shell structure of the mollusks. D. Kgl. Danske Vidensk. Selsk. Skrifter, Naturvidensk., 9 (II.2): 233-326, 15 pls., 10 text-figs.
- Boss, K. J. and V. C. Kenk. 1964. Anatomy and relationships of *Temnoconcha brasiliensis* Dall. Occ. Papers Mollusks, Harvard University, 2: 325-343, pls. 56-60.
- Carcelles, A. 1944. Catálogo de los moluscos marinos de Puerto Quequén. Revista Museo La Plata (N.S.), Zoología, 3: 233-309, 15 pls.
- Chemnitz, J. H. 1782. Neues systematisches Conchylien-Cabinet. Nürnberg, vol. 6, 375 pp., 36 pls.
- Children, J. G. 1823. Lamarck's Genera of Shells. Quart. Jour. Sci., Lit., and Arts, 14: 32.
- Clench, W. J. and R. D. Turner. 1950. The western Atlantic marine mollusks described by C. B. Adams. Occ. Papers Mollusks, Harvard University, 1: 233-403, pls. 28-49.
- Conrad, T. A. 1841. Appendix to Mr. Hodge's paper, describing the new shells. Amer. Jour. Sci., 1st ser., 41: 344-348, pl. 2.
- Conrad, T. A. 1873. Description of new genera and species of fossil shells of North Carolina, in the state cabinet at Raleigh, [in] W. C. Kerr, Report of the Geological Survey of North Carolina [1875]. Raleigh, vol. 1, appendix A, pp. 1-18, 4 pls.
- Cooke, C. W., J. Gardner, and W. P. Woodring. 1943. Correlation of the Cenozoic formations of the Atlantic and Gulf Coastal Plain and the Caribbean Region. Bull. Geo. Soc. Amer., 54: 1713-1723, chart no. 12.
- Cossmann, A. E. M. 1886. Catalogue des coquilles fossiles d'Eocene des environs de Paris. Pélécypodes. Ann. Soc. Roy. Malac. Belg., 21 (4th Sér., vol. 1): 17-186, pls. 1-8.
- Costello, D. P., M. E. Davidson, A. Eggers, M. H. Fox, and C. Henley. 1957. Methods for obtaining and handling marine eggs and embryos. Marine Biological Laboratory, Woods Hole, Massachusetts, 247 pp.
- Dall, W. H. 1889. A preliminary catalogue of the shell-bearing marine mollusks and brachiopods of the southeastern coast of the United States. U. S. Nat. Mus., Bull. 37, 221 pp., 74 pls.
- Dall, W. H. 1900. Tertiary fauna of Florida. Trans. Wagner Free Inst. Sci. Philadelphia, 3(5): 985-1001.
- Dall, W. H. 1903. A preliminary catalogue of the shell-bearing marine mollusks and brachiopods of the southeastern coast of the United States. U. S. Nat. Mus., Bull. 37 (reprint), 232 pp., 95 pls.
- Dall, W. H. 1915. Notes on the Semelidae of the west coast of America, including some new species. Proc. Acad. Nat. Sci. Philadelphia, 67: 25-28.
- Dall, W. H. and C. T. Simpson. 1901. The Mollusca of Porto Rico. Bull. U. S. Fish Comm. [1900], 20: 351-524, pls. 53-58.
- Dautzenberg, P. 1900. Croisières du yacht *Chazalie* dans l'Atlantique. Mollusques. Mem. Soc. Zool. France, 13: 145-265, pls. 9-10.
- Davis, C. A. 1904. Notes on the mollusca of the Bermuda Islands. Nautilus, 17: 125-130.
- Dodge, H. 1952. A historical review of the mollusks of Linnaeus. Part 1. The Classes Loricata and Pelecypoda. Bull. Amer. Mus. Nat. Hist., 100, 264 pp.
- Doello-Jurado, M. 1949. Dos nuevas especies de bivalvos marinos. Comunicaciones zoologicas Museo Historia Natural Montevideo, 3(57): 1-8, 3 figs.
- Dohrn, H. 1880. Beiträge zur Kenntniss der Seeconchylien von Westafrika. Jahrb. deutsch. malak. Gesell., 7: 161-183.
- Dunker, G. 1853. Index molluscorum quae in itinere ad Guinean inferiorem collegit G. Tams. Cassel, 74 pp., 10 pls.
- Duvernoy, M. 1853. Mémoires sur le système nerveux des mollusques acéphales. Mém. Acad. Sci., Paris, 24: 3-312.
- Figueiras, A. and O. Sicardi. 1968. Catálogo de los moluscos marinos del Uruguay. (III). Com. Soc. Mal. Urug., 2(16-17): 355-375, 2 pl.
- Gabb, W. M. 1881. Descriptions of new species of fossils from the Pliocene Clay Beds between Limon and Moen, Costa Rica, together with notes on previously known species from there and elsewhere in the Caribbean Area. Jour. Acad. Nat. Sci. Philadelphia, ser. 2, 8(4): 349-380.
- GABB, W. M. 1873. On the topography and geology of Santo Domingo. Trans. Amer. Philos. Soc., 15: 49-259.
- GARDNER, J. 1928. The molluscan fauna of the Alum Bluff Group of Florida. Part V. Tellinacea. . . . U. S. Geol. Surv., Prof. Paper 142-E, pp. 185-249, pls. 29-36.
- Gardner, J. 1943. Mollusca from the Miocene and Lower Pliocene of Virginia and North Carolina. Pt. 1. Pelecypoda. U. S. Geol. Surv., Prof. Paper 199-A, 178 pp., 23 pls.
- Gmelin, J. F. 1791. Caroli a Linné Systema naturae. Ed. 13. Lipsiae, vol. 1, pt. 6 [Vermes], pp. 3021-3910.
- Graham, A. 1934. The structure and relationships of lamellibranchs possessing a cruciform muscle. Proc. Roy. Soc. Edinburgh, 54: 158-187.
- Grave, B. H. 1927. The natural history of *Cumingia tellinoides*. Biol. Bull., 53: 208-219.
- Goffert, C. N. 1950. Contribuição à zoogeografia da malacofauna do litoral do Estado do Paraná. Arq. Museu Paranaense Curitiba, 8(7): 221-282, pls. 31-35.
- Gualtieri, N. 1742. Index testarum conchyliorum quae adservantur in Museo Gualtieri. Florence, 23 pp., 110 pls.
- Guppy, R. J. L. 1867. On the Tertiary fossils of the West-Indies, with especial reference to the classification of the Kainozoic rocks of Trinidad. Proc. Sci. Assoc. Trinidad, pt. 1, pp. 145-176.
- Guppy, R. J. L. 1874. On the West Indian Tertiary fossils. Geological Magazine, Decade II, vol. 1, nos. 9 and 10, pp. 1-22 [433-454], pls. 16-18.
- Guppy, R. J. L. 1877. First sketch of a marine invertebrate fauna of the Gulf of Paria and its neighborhood. Proc. Sci. Assoc. Trinidad, pt. 9, pp. 134-157.
- Guppy, R. J. L. 1894. The mollusca [sic] of the Gulf of Paria. Proc. Victoria Inst. Trinidad, pt. 2, pp. 116-152.
- Hackney, A. G. 1944. List of mollusca from around

- Beaufort, N. Carolina, with notes on *Tethys*. Nautilus, 58: 56-64.
- Harris, G. D. 1919. Pelecypoda of the St. Maurice and Claiborne Stages. Bull. Amer. Paleo., 6(31): 1-268, 59 pls.
- Hertlein, L. G. and A. M. Strong. 1949. Eastern Pacific Expeditions of the New York Zoological Society. XLI. Mollusks from the West Coast of Mexico and Central America. Part VIII. Zoologica, 34: 239-258, pl. 1.
- Hidalgo, J. G. 1903. Part 1. Estudios preliminares sobre la fauna malacológica de las Islas Filipinas. Vol. 2, fasc. 1. Mem. Real Acad. Cien. Madrid, 21: 1-400.
- Holmes, F. S. 1858. Post-Pleiocene fossils of South Carolina. Charleston, 122 pp., 28 pls.
- von Ihering, H. 1907. Les mollusques fossiles du Tertiaire et du Crétacé Supérieur de l'Argentine. Anales Museo Nacional Buenos Aires, ser. 3, 7, 611 pp., 18 pls., 16 figs.
- Johnson, R. I. 1964. The Recent Mollusca of Augustus Addison Gould. U. S. Nat. Mus., Bull. 239, 182 pp., 42 pls.
- Keen, A. M. 1958. Sea shells of tropical west America. Stanford Univ. Press, 624 pp., 1709 figs., 10 color pls.
- Kellogg, J. L. 1915. Ciliary mechanisms of lamellibranchs with descriptions of anatomy. Jour. Morph., 26: 625-701.
- Klappenbach, M. 1968. *Semele martinii* (Reeve, 1853) of Southern Brazil and Uruguay. Veliger, 10(3): 274.
- Lamy, E. 1912. Notes synonymiques sur les *Amphidesma* de Lamarck (no. 3). Bull. Mus. Hist. Nat. Paris, 18: 160-166.
- Lamy, E. 1914. Révision des Scrobiculariidae vivants. Jour. de Conchyl., 61: 243-268, pl. 8.
- Lamy, E. 1915. Note sur le *Semele nuculoides* Conrad. Bull. Mus. Hist. Nat. Paris, 21(1): 17-18, fig. 1.
- Lamy, E. 1923. Campagne du *Sylvania*, mission de Polignac et Gain. Moll. testacés. C. R. Congr. Soc. Sav. [1922], Sci., pp. 22-37.
- Lecointre, G. and A. Serralheiro. 1967. Sur quelques coquilles vivantes et fossiles de l'Archipel du Cap Vert. Jour. de Conchy., [1966], 105(4): 216-220.
- Linnaeus, C. 1758. Systema naturae per regna tria naturae . . . editio decima, reformata. Stockholm, vol. 1, Regnum animale, 824 pp.
- Linnaeus, C. 1767. Systema naturae per regna tria naturae . . . editio duodecima, reformata. Stockholm, vol. 1, pt. 2, pp. 533-1327.
- Lister, M. 1685 [-1692]. Historiae sive synopsis methodicae conchyliorum. London.
- Lopes, H. de S. and M. Alvarenga. 1955. Contribuição ao conhecimento dos moluscos da Ilha Fernando de Noronha-Brasil. Bol. Inst. Ocean. (São Paulo), 6: 157-196.
- Mansfield, W. C. 1932. Miocene pelecypods of the Choctawhatchee Formation of Florida. Fla. State Geol. Surv., Bull. 8, 240 pp., 34 pls.
- von Martens, E. 1902. Die Mollusken (Conchylien) und die übrigen wirbellosen Thiere in Rumph's Rariteitkamer. Rumphius Gedenkboek. Haarlem, pp. 109-136.
- Maury, C. J. 1917. Santo Domingo type sections and fossils. Bull. Amer. Paleo., 5(29): 419-459.
- Maury, C. J. 1920. Recent molluscs of the Gulf of Mexico and Pleistocene and Pliocene species from the Gulf states. Pelecypoda. Pt. 1. Bull. Amer. Paleo., 8(34): 3-115, 1 pl.
- Maury, C. J. 1925. A further contribution to the paleontology of Trinidad. Bull. Amer. Paleo., 10(42): 152-402.
- McGinty, T. L. 1955. New marine mollusks from Florida. Proc. Acad. Nat. Sci. Philadelphia, 107: 75-85.
- McNulty, J. K., R. C. Work, and H. B. Moore. 1962. Level sea bottom communities in Biscayne Bay and neighboring areas. Bull. Mar. Sci. Gulf and Caribbean, 12(2): 204-233.
- Mörch, O. A. L. 1853. Catalogus conchyliorum quae reliquit D. Alphonso d'Aguirra et Gadea, Comes de Yoldi. Hafniae, 76 pp.
- Moore, D. R. 1961. The marine and brackish water Mollusca of the State of Mississippi. Gulf Research Reports, 1(1), 58 pp.
- Moore, E. J. 1962. Conrad's Cenozoic fossil marine mollusk type specimens at the Academy of Natural Sciences of Philadelphia. Proc. Acad. Nat. Sci. Philadelphia 114: 23-120.
- Morretes, F. Lange de. 1940. Algumas palavras sobre novas ocorrências e maior distribuição de moluscos na costa do Brasil. Revista de Industria Animal, nova série, 3(4): 184-187.
- Morretes, F. Lange de. 1949. Ensaio de catálogo dos moluscos do Brasil. Arq. Mus. Paranaense, 7(1): 5-216.
- Newell, N. D. 1965. Classification of the Bivalvia. Amer. Mus. Novitates, no. 2206, 25 pp.
- Nicklès, M. 1947. La collection de Mollusques testacés marins de l'I.F.A.N. Publ. I.F.A.N. (Dakar), Catalogues 1, 23 pp.
- Nicklès, M. 1950. Mollusques testacés marins de la côte occ. d'Afrique. Manuels Ouest-africains (Paris), no. 2, 269 pp., 464 figs.
- Nicklès, M. 1952. Mollusques testacés marins du littoral de l'A.E.F. Jour. de Conch., 29: 143-154.
- Nicklès, M. 1955. Scaphopodes et lamellibranches récoltés dans l'ouest africain. Atlantide Rept. no. 3 (Copenhagen), pp. 94-237, 41 figs.
- Nobre, A. 1909. Matériaux pour l'étude de la faune malacologique des possessions portugaises de l'Afrique occidentale. Bull. Soc. Port. Sci. Nat., 3 (suppl. 2), 108 pp.
- Oberling, J. J. 1964. Observations on some structural features of the pelecypod shell. Mitt. Naturforsch. Gesell. Bern., N. F., 20: 1-64, 6 pls., 3 text figs.
- Odhner, N. 1912. Morphologische und phylogenetische Untersuchungen über die Nephridien der Lamellibranchien. Zeits. für wissen. Zool., 100: 287-391, 40 text figs.

- Olsson, A. A. 1961. Mollusks of the Tropical Eastern Pacific. Panamic-Pacific Pelecypoda. Paleo. Research Inst., Ithaca, N. Y., 574 pp., 86 pls.
- Olsson, A. A. and A. Harbison. 1953. Pliocene Mollusca of southern Florida. Acad. Nat. Sci. Philadelphia, Monograph 8, Pt. 1, 361 pp.
- Olsson, A. A. and T. McGinty. 1958. Recent marine mollusks from the Caribbean coast of Panama. Bull. Amer. Paleo., 39(177): 1-58, 5 pls.
- Parker, R. H. 1956. Macro-invertebrate assemblages as indicators of sedimentary environments in East Mississippi Delta Region. Bull. Amer. Assoc. Pet. Geol., 40(2): 295-376, 8 pls., 32 figs.
- Parker, R. H. 1959. Macro-invertebrate assemblages of central Texas coastal bays and Laguna Madre. Bull. Amer. Assoc. Pet. Geol., 43(9): 2106-2166, 32 figs.
- Peile, A. J. 1926. The mollusca of Bermuda. Proc. Malac. Soc. London, 17: 71-98.
- Perry, L. M. and J. S. Schwengel. 1955. Marine shells of the western coast of Florida. Paleo. Research Inst., Ithaca, N. Y., 318 pp., 55 pls.
- Pulley, T. E. 1952. An illustrated check list of the marine mollusks of Texas. Texas Jour. Sci., 2: 167-199, 13 pls.
- Pulteney, R. 1813. Catalogues of the birds, shells, and some of the more rare plants of Dorsetshire. [*in*] Hutchins, John. The History and Antiquities of the County of Dorset, 2nd ed. 108 pp., 23 pls.
- Reeve, L. 1853. Conchologia Iconica, vol. 8, *Amphidesma*, 7 pls., 53 species.
- Rice, E. L. 1897. Die systematische Verwertbarkeit der Kiemen bei den Lamellibranchiaten. Jena. Zeits. Naturwissen., 31: 29-89, 2 pls.
- Ridewood, W. G. 1903. On the structure of the gills of the Lamellibranchia. Phil. Trans. Roy. Soc. London, Ser. B, 195: 147-284, 61 figs.
- Rios, E. C. and P. S. Cardoso. 1967. Lista preliminar de los moluscos marinos de Alagoas. Com. Soc. Malac. Urug., 2(13): 117-135.
- Robertson, R. 1960. Marine mollusks of Bimini, Bahama Islands. Unpublished Ph.D. Dissertation, Harvard University, 294 pp.
- de Rocheburne, A. T. 1881. Matériaux pour la faune de l'Archipel du Cap Vert. Nouv. Arch. Muséum, sér. 2, 4: 215-340.
- Rumphius, G. E. 1705. D'Amboinsche Rariteitkamer, etc., Amsterdam, 340 pp., 60 pls.
- Sacco, F. 1901. I Molluschi dei Terreni Terziarii del Piemonte e della Liguria. Parte 29. Clausen, Torino, 160 pp., 29 pls.
- Skarlato, O. A. 1965. Bivalve mollusks of the superfamily Tellinacea of the China Sea. Studia Marina Sinica, No. 8, pp. 27-114, pls. 1-8, pp. 27-103 (in Chinese), pp. 104-114 (in Russian).
- Schröder, O. 1916. Beiträge zur Anatomie von *Amphidesma solidum*. Jena. Zeits. Naturwissen., 54: 101-132, 13 figs.
- Schumacher, C. F. 1817. Essai d'une nouveau système des habitations des vers testacés. Copenhagen, 287 pp., 22 pls.
- Singley, J. A. 1893. Contributions to the natural history of Texas. Pt. 1. Texas Mollusca. Preliminary list of the land, fresh water and marine mollusca of Texas. 4th Ann. Report Geol. Survey Texas, Pts. 1 and 2, pp. 299-343.
- Smith, E. A. 1885. Report on the Lamellibranchiata collected by H. M. S. *Challenger*. Rept. Scientific Results. Voyage of H. M. S. *Challenger*. Zoology, 13: 1-341, 25 pls.
- Smith, E. A. 1890a. Report on the marine molluscan fauna of the island of St. Helena, Proc. Zool. Soc. London, pp. 247-317, 4 pls.
- Smith, E. A. 1890b. Mollusca of Fernando de Noronha. Jour. Linn. Soc., 22: 483-503.
- Smith, E. A. 1890c. On the marine Mollusca of Ascension Island. Proc. Zool. Soc. London, pp. 317-322.
- Smith, E. A. 1915. Mollusca. Part 1. Gastropoda Prosobranchia, Scaphopoda and Pelecypoda. British Antarctic ("Terra Nova") Expedition, 1910. Nat. Hist. Rept., Zoology, 2(4): 61-112, 2 pls.
- Spengler, L. 1798. Over det toskallede slaegt tellinerne. Skrivter af Naturhistorie Selskabet, København, 4(2): 67-127.
- Stanley, S. M. 1970. Relation of shell form to life habits of the Bivalvia (Mollusca). Geo. Soc. Amer., Mem. 125, 296 pp., 40 pls.
- Stoliczka, F. 1871. Memoirs Geol. Survey India. Palaeontologia Indica. Cretaceous Fauna of southern India, 3: 1-537.
- Tomlin, J. R. le B. and L. J. Shackelford. 1914. The marine Mollusca of São Thomé, I. Jour. Conch., 14: 239-276.
- Tristram, H. B. 1861. Catalogue of a collection of mollusks from Bermuda. Proc. Zool. Soc. London [1864], pt. 3, pp. 403-405.
- Trueman, E. R. 1953. The structure of the ligament of the Semelidae. Proc. Malac. Soc. London, 30: 30-36, 4 text figs.
- Tuomey, M. and F. S. Holmes. 1856. Pleiocene fossils of South Carolina. Charleston, 152 pp., 32 pls.
- Vanatta, E. G. 1903. A list of shells collected in western Florida and Horn Island, Mississippi. Proc. Acad. Nat. Sci. Philadelphia, 55: 756-759.
- Weisbord, N. E. 1926. Notes on marine mollusks from the Yucatan Peninsula. Nautilus, 39: 81-87.
- Weisbord, N. E. 1964. Late Cenozoic pelecypods from northern Venezuela. Bull. Amer. Paleo., 45(204), 564 pp., 59 pls.
- White, K. M. 1942. The pericardial cavity and the pericardial gland of the Lamellibranchia. Proc. Malac. Soc. London, 25: 37-88.
- Whitfield, R. P. 1894. Mollusca and Crustacea of the Miocene formations of New Jersey. U. S. Geol. Surv. Monograph 24, 193 pp., 24 pl.
- Wood, W. 1815. General Conchology. London, Vol. 1, 246 pp., 59 pls.
- Yonge, C. M. 1949. On the structure and adaptations of the Tellinacea. Phil. Trans. Roy. Soc. London, ser. B, 234: 29-76.
- Zittel, K. A. von. (trans. by C. R. Eastman). 1900. Text book of Paleontology. New York, vol. 1, 390 pp.

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THE GENUS *CERITHIUM* IN THE WESTERN ATLANTIC

(Cerithiidae: Prosobranchia)

BY

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ABSTRACT

The western Atlantic species of the molluscan prosobranch genus *Cerithium* are reviewed. Six species are recognized: *Cerithium litteratum*, *C. atratum*, *C. eburneum*, *C. guinaicum*, *C. lutosum*, and *C. muscarum*.

General discussions of the zoogeography, fossil history, and biology of the genus are included along with a description of shell characters. Problems surrounding the selection of a type-species for the genus are reviewed and the status of subgeneric taxa is discussed. The subgenus *Thericium* is suggested for the western Atlantic *Cerithium* species and a synonymy of *Thericium* is presented. The gross anatomy is treated and a detailed discussion of the pallial gonoducts and other reproductive structures is provided.

A key to the six species is constructed and a discussion of the biology, synonymy, and fossil history of each is given. The geographical distribution of each species is determined on the basis of examination of museum specimens and literature citations.

INTRODUCTION

Members of the genus *Cerithium* are found in the intertidal and subtidal shallow

waters throughout the tropical and subtropical marine provinces of the world. Many sympatric species occupy a rather uniform trophic position in these habitats where they feed upon micro-algae and detritus. They often occur in large populations of high density. Variability, in shell color, form, size and sculpture, is a common trait in most *Cerithium* species and identification of individuals to the species level is often difficult. These difficulties are compounded by the fact that many species were described and over-named early in the period of the typological species concept. The authors of this period frequently provided only truncated descriptions with little or no locality data, and figures, if given, were sometimes poor. The type-material of some species is lost, and the confusion surrounding the selection of a proper type-species for the genus is, in itself, something of a classic in taxonomic inscrutability (Houbrick, 1974a). The genus has been monographed several times; notably by Kiener (1841-1842), Sowerby (1855; 1865), Tryon (1887), and Kobelt (1898).

I have recently completed several studies on the biology of *Cerithium* (Houbrick, 1970; 1971; 1974b; 1974c). Reproductive

studies indicate that egg masses are species distinct in some cases, particularly in those species where development is completed in the egg capsule. The potential importance of the taxonomic characters of planktotrophic veligers has been indicated by D'Asaro (1969) and larval protoconchs have been frequently used as taxonomic tools; however, the eggs of planktotrophic species are quite similar and veligers of species with planktonic stages are virtually indistinguishable. In most cases, larval protoconchs are either missing or badly eroded in adult shells.

Ecological studies, while not exhaustive, reveal that some species vary in their vertical distribution on the shore. My studies in Florida (Houbrick, 1974b) indicate that most species have a life-span of about one year and that spawning usually occurs from late winter through early summer.

All species of *Cerithium* that I examined are style-bearing algal-detritus feeders. Their stomachs are highly specialized for the sorting and transport of small particles, indicating that particle selection is taking place and that ecological niches are probably determined to some degree, on this basis. I was unable to determine any significant behavioral differences between species.

Morphological studies show that the animals of the genus *Cerithium* are similar and that gross anatomy is an unsatisfactory and impractical taxonomic tool, at least at the species level. The genus is aphyllous and the open, pallial gonoducts are similar in all species I have examined. At least one species produces spermatophores. Variation in radular characteristics is common; the number of cusps on a radular tooth often varies on the same ribbon. The radula is thus not of taxonomic value, at least at the light microscope level. Rosewater (1970) found this to be true for the littorinids. The operculum is likewise a poor diagnostic feature.

On the basis of these results, one is forced to rely upon shell characters as the most practical, conservative means of separating

species. These can be reliable provided one takes into account variation exhibited by the genus. In this study, I have attempted to apply modern biological species concepts (Mayr, 1966) to the genus and have included anatomical, reproductive and ecological characters, when possible, to augment the descriptive first stages of *alpha* taxonomy. In the past, genetic and ecological variability were ignored and this has given rise to an enormous and discouraging synonymy. In this revision, I have tried to consolidate the genus using a biological approach. While this, of necessity, has included subjectivity in taxonomic decisions, I believe that the systematic status of the genus *Cerithium* in the western Atlantic has been considerably clarified.

Geographic Distribution:

The genus *Cerithium* comprises a warm-water group that inhabits shallow tropical and warm temperate seas. Abbott (1962) estimated that there are about 300 species in the world, but as Cernohorsky (1972) has indicated, many of these accepted species will disappear in synonymy when modern revisions are undertaken. Abbott's figure is undoubtedly exaggerated by the excessive number of synonyms and may include species of closely related genera such as *Rhinoclavis*, *Pseudovertagus*, *Clypeomorus* and *Liocerithium*. Most modern workers do not agree on the limits of the above genera and when one considers the plethora of sub-genera that have been erected for the genus *Cerithium* and the difference of opinion as to what constitutes valid generic or subgeneric groups, the problem of making an accurate estimate of the number of species is compounded.

There have been no recent comprehensive reviews of the genus except that of Keen (1971) for the Panamic species. A few more abbreviated treatments of the genus are presented in popular shell books (Abbott, 1954; Abbott and Warmke, 1961; Cernohorsky, 1972; and Wilson and Gillett, 1972). In this review the 41 named taxa from the

western Atlantic are reduced to six valid species and no doubt future research on the genus in other faunal provinces will yield similar results. I conservatively estimate that there are about 45 living species of the genus *Cerithium* in the world. A breakdown by faunal provinces follows:

Indo-Pacific	20 species
Eastern Pacific	12 species
Western Atlantic	6 species
Eastern Atlantic and Mediterranean	7 species

The Indo-Pacific Province has the most species, but many of these are in need of a critical review before a reliable estimate can be made. In this province the genus extends north to central Japan and Hawaii, south to Queensland and Western Australia, east to the Tuamotus and west throughout the Indian Ocean and the Red Sea.

In the eastern Pacific, *Cerithium* species are found from Baja California south to northern Peru and west to Clipperton Island and the Galápagos.

In the Atlantic, two species have an amphiatlantic distribution, but four occur only in the western Atlantic. Chesher (1966) and Briggs (1970) have indicated that the majority of trans-Atlantic invertebrates originated in the western Atlantic and then migrated eastward. Western Atlantic species occur as far north as South Carolina and extend south throughout the Gulf of Mexico and the Caribbean to southern Brazil. In the eastern Atlantic *Cerithium* species are found from the Bay of Biscay south to South Africa. The genus also occurs throughout the Mediterranean and in the Black Sea.

Fossil History:

The genus *Cerithium* originated in the Jurassic Period and reached its maximum development during the Eocene Epoch (Sohl, 1960; Hoerle, 1972). Cossmann (1889) has recorded numerous representatives in the Eocene of the Paris Basin. Two reviews on the phylogeny of the Cerithiidae have been presented (Cossmann, 1906; Wood, 1910). The genus had numerous representatives in

the western Atlantic fauna during the Tertiary but the excessive number of subdivisions created for this group often obscure the relationships and it is difficult to decide what should be included under *Cerithium*, *sensu stricto*; consequently a comprehensive treatment of the fossil species of *Cerithium* in the western Atlantic is beyond the scope of this review. Comments on the fossil relationships of Recent species follow in the text under each species. The paleontological background of the genus *Cerithium* in North America and the Caribbean region is still little understood, and despite the great amount of material available, much of it is scattered and the records are incomplete. Dall (1892; 1915) recorded about 18 species from the Tertiary of North America; eleven species were described from the Pliocene of St. Petersburg, Florida by Olsson and Harbison (1953). Gardiner (1945) described 5 species from the Tertiary of northeastern Mexico and, more recently, Hoerle (1972) has reported on the *Cerithium* species from the Chipola Formation of Northwestern Florida. Gabb (1881), Woodring (1928; 1959), Maury (1920) and Weisbord (1962) have described Tertiary species from the Caribbean. Nearly all of the living western Atlantic species of *Cerithium* were also represented in the Pliocene-Pleistocene epochs. Davis (1971) has suggested that cerithiaceans are a slow-evolving group.

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ABBREVIATIONS USED IN PLATES

a	anus
aes	anterior esophagus
ag	albumen gland
au	auricle
bg	buccal ganglion
cg	capsule gland
cga	cerebral ganglion
cm	columellar muscle
cs	crystalline style
ct	ciliated tube
cte	ctenidium
dg	digestive gland
drs	distal seminal receptacle
dt	dorsal typhlosole
e	eye
emc	end of mantle cavity
epp	epipharyngeal pouches
es	opening of esophagus
ex	exhalent siphon
f	foot
g	gonad
gd	gonadal duct
gs	gastric shield
hg	hypobranchial gland
in	inhalent siphon

int	intestine
into	intestine opening
k	kidney
ko	kidney opening
ld	liver duct
ll	lateral lamina
lr	large ridge
m	mouth
me	mantle edge
ml	medial lamina
o	ovary
od	ovarian duct
odt	odontophore
og	oviducal groove
op	operculum
os	osphradium
pes	posterior esophagus
pgd	pallial gonoduct
pgl	pleural ganglion
prs	proximal seminal receptacle
pt	pallial tentacles
r	radula
rs	radula sac
sa	sorting area
scg	sperm collecting gutter
scp	sperm collecting pouch
sec	supra-esophageal connective
sn	snout
ss	style sac
stm	stomach
t	tentacle
ve	ventricle
vt	ventral typhlosole

ABBREVIATIONS USED IN TEXT

AMNH	American Museum of Natural History
ANSP	Academy of Natural Sciences of Philadelphia
COP	Copenhagen Museum
LACM	Los Angeles County Museum of Natural History
MCZ	Museum of Comparative Zoology
MHNG	Muséum d'Histoire Naturelle Geneva
SMF	Senckenberg Museum, Frankfurt
UMML	University of Miami Marine Laboratory
USNM	United States National Museum of Natural History

SYSTEMATIC TREATMENT

Superfamily Cerithiacea

Family Cerithiidae Fleming 1828

Genus **Cerithium** Bruguière

Cerithium Bruguière 1789, Encyc. Method. Hist. Natur. Vers., 1: xv (described, but no species listed); 1792, *Ibid.*, p. 467, 479 (type-species, by tautonymy, *Cerithium adansonii* Bruguière; see Stewart, 1926; Houbbrick, 1974 a).

Contumax Hedley 1899, Mem. Australian Mus. (7) 3: 436-437, fig. 25 (type-species, by original designation, *Contumax decollatus* Hedley [= *Cerithium nodulosum* Bruguière]).

Description. Shell of medium to large size with long turreted spire of many whorls. Protoconch small and usually missing in adults. Whorls separated by indistinct sutures and sculptured with irregular spiral cords which may be beaded, knobbed, or comprise tuberculate ribs. Varices scattered at intervals along spire whorls; prominent varix on last whorl opposite outer lip. Aperture circular to ovate; outer lip somewhat flared and crenulate. Basal portion of outer lip may project over siphonal canal. Siphonal canal of medium length and recurved towards the left. Anal canal distinct and defined by columellar plica extending well within shell. Columella slightly curved and smooth except for anal sulcus; moderate spread of callus over the parietal wall. Operculum thin, chitinous, ovate and paucispiral with an eccentric nucleus. Periostracum colorless and thin. Head with broad snout, eyes at base of short tentacles. Radular ribbon long, taenioglossate (2-1-1-1-2). Pallial gonoducts open. Aphallic. Egg capsules deposited in stringy, jelly-like masses. Development totally within capsules or with free-swimming veligers. Algal-detritus feeders with crystalline style.

Remarks. Although the name *Cerithium* has been used by generations of workers, the genus has had a complicated taxonomic history and is difficult to define due to the problems in selecting and identifying a proper type-species. This has led workers to designate different species as the type-species for the genus such as *Cerithium adansonii* Bruguière, *C. tuberosum* Columna, *C. nodulosum* Bruguière, *C. virgatum* Linnaeus, and *Clava aluco* Lamarck.

Bruguière (1789) was the first author to use the name *Cerithium* but he failed to list any species. He adopted the name from Adanson (1757) whose work is non-binomial. Three years later, Bruguière (1792) divided the genus into three unnamed groups on the basis of siphonal canal curvature. The first of these groups corresponds to what is now known as *Rhinoclavis* Swainson 1840 and the second to *Cerithium*, *sensu stricto*. Bruguière listed 10 species in his second group, naming a shell of Adanson's, *Cerithium adansonii*, with "Le Cerite" Adanson cited in its synonymy. The first valid subsequent designation of a type-species for the genus was that of Montfort (1810) who chose *Cerithium virgatum*, a substitute name for *Murex vertagus* Linnaeus [= *Rhinoclavis vertagus* Linnaeus]. It is thus clear that the name *Cerithium* would replace the well-known name *Rhinoclavis* Swainson 1840 (previously known as *Clava* Martyn 1784) if Montfort's designation is accepted.

Stewart (1926), following the lead of Vignal (1910), proposed that *C. adansonii* Bruguière should be the type-species by indirect virtual tautonymy because Bruguière (1792) cited "Le Cerite" Adanson in the synonymy. Adanson's species has been definitely determined by Fischer-Piette (1942) to be *C. erythraeonense* Lamarck, a true *Cerithium*. Stewart's usage, as noted by Sohl (1960), has not met with universal approval, but if Bruguière's *C. adansonii* is not accepted as the type-species, Montfort's designation of *C. virgatum* [= *Rhinoclavis vertagus*] must be selected as the valid type; *Cerithium* would replace what has been long been known as *Rhinoclavis* and more confusion would be introduced into the nomenclature.

MacNeil (1960) has accepted Montfort's designation and has placed *Rhinoclavis*, which

MacNeil (1960) has accepted Montfort's designation and has placed *Rhinoclavis*, which

he calls *Clava*, into the synonymy of *Cerithium*. I believe that this choice is unwise because the transfer of the name *Cerithium* from one large, well-known cerithiid group (*Cerithium*) to another (*Rhinoclavis*) will only serve to confuse the issue further. Vignal (1910) and Cossman (1889) have both used *C. adansonii* as the type-species for the genus, and Stewart's proposal of the acceptance of *C. adansonii* as the type-species by tautonymy has been accepted by other recent workers: Olsson and Harbison (1953), Woodring (1959), Sohl (1960) and Hoerle (1972). I have recently reviewed the synonymic history of the genus *Cerithium* in more detail (Houbrick, 1974a), and acting on Woodring's (1959) suggestion, have petitioned the International Commission on Zoological Nomenclature to preserve the name *Cerithium* by referring the genus to Bruguière and designating *Cerithium adansonii* Bruguière 1792 as the type-species.

Hedley (1899) created the genus *Contumax* on the basis of a species, *C. decollatus* from Funafuti in the Pacific, but his species appears to be an immature specimen of the common Indo-Pacific *Cerithium nodulosum* (Iredale 1930). Examination of museum series of *C. nodulosum* with differing growth stages confirms this fact. *C. nodulosum* is closely related to *C. erythraeonense* from the Red Sea, the type-species of the genus, and the latter may merely be a subspecies or geographic race of *C. nodulosum*. Consequently, *Contumax* is a synonym of *Cerithium*.

Range. Worldwide; shallow water tropical and subtropical seas.

Subgenus **Theridium** Monterosato

Theridium Monterosato 1890, Naturalista Siciliano 9(7): 163 (type-species, by original designation, *C. vulgatum* Bruguière 1789).

Gourmierium Jousseume 1894, Bull. Soc. geol. France, 21(3): 396 (no description, 3 species cited [*G. vulgatum*, *G. rupestre*, *G. pulchellum*]; type-species, here selected, *G. vulgatum* Bruguière 1789).

Goumierium (emnd. *pro* *Gour.* — Jousseume 1894) Monterosato 1910, Giorn. Sci. nat. Palermo, 28: 66.

Vulgocerithium Cossmann 1906, Moll. Terr. terz. Pie-

monte Liguria 17:7 (type-species, by original designation, *V. vulgatum* Bruguière 1789).

Pithocerithium Sacco 1895, [in] Bellardo and Sacco, Moll. Terr. terz. Piemonte Liguria 17: 28. (type-species, by original designation, *P. doliolum* Brocchi 1814 [= *C. rupestre* Risso]).

Pliocerithium Monterosato 1910, Giorn. Sci. nat. Palermo, 28: 67, pl. 1 (type-species, by original designation, *P. holothurium* Monterosato [= *C. vulgatum* Bruguière]).

Gladiocerithium Monterosato 1910, Giorn. Sci. nat. Palermo, 28: 68, pl. 1 (type-species, by original designation, *G. alucastrium* Brocchi 1814 [= *C. vulgatum* Bruguière]).

Drillocerithium Monterosato 1910, Giorn. Sci. nat. Palermo, 28:71, pl. 1 (type-species, here designated *D. protractum* Bivona 1838 [= *C. vulgatum* Bruguière]).

Hirtocerithium Monterosato 1910, Giorn. Sci. nat. Palermo, 28: 73, pl. 1 (type-species, by monotypy, *H. pugioniform* Monterosato [= *C. vulgatum* Bruguière]).

Lithocerithium Monterosato 1910, Giorn. Sci. nat. Palermo, 28: 75 (type-species, by monotypy, *L. fuscum* Costa 1829 [= *C. rupestre* Risso]).

Description. Shell small to medium with long spire of many whorls (6-13). Whorls separated by weak sinus and sculptured with spiral cords which may be beaded or nodular; nodes sometimes prominent at periphery or extending radially to form axial riblets. Several varices scattered on whorls; varix opposite outer lip on body whorl. Outer lip slightly expanded, moderately crenulate. Siphonal canal short, moderately recurved; anal canal short. Columella slightly curved or straight with weak fold bordering anal sinus.

Remarks. Most workers have placed the western Atlantic species of *Cerithium* in the subgenus *Theridium* Monterosato 1890 (Woodring, 1928; 1959; Olsson and Harbison, 1953; Rehder, 1940; Hoerle, 1972). Monterosato, in a one sentence statement, used a manuscript name of Rochebrune and proposed *Theridium* as a genus, stating only that *C. vulgatum* was the type. The only description was his statement that true *Cerithium* had as its type, *C. nodulosum* Bruguière, and did not occur in the Mediterranean. Monterosato named *Theridium alucastrium* Brocchi, a synonym of *C. vulgatum* Bruguière, the type-species of his genus. *Cerithium vulgatum* is an exceedingly variable species and has been subject to much

splitting. This is particularly reflected in the works of some European malacologists and paleontologists who have been rather arbitrary in creating not only new species but even higher categories on the basis of one or only a few specimens of the *C. vulgatum* complex.

Woodring (1928) indicated his own uncertainty as to the generic recognition of *Theridium*. He later (1959) used *Theridium* as a sub-genus of *Cerithium*. Grant and Gale (1931) commented that a separation of *Theridium* from *Cerithium* is more artificial than natural and mentioned that the cerithiids have apertural and sculptural characters that occur in confusing combinations which render sub-generic separations impractical. More recently, Strausz (1966) made *Theridium* a synonym of *Cerithium*, while Nordieck (1968) proposed *Theridium* as a sub-genus of *Gourmya* Bayle, 1884. Most modern workers have considered *Theridium* to be a sub-genus of *Cerithium*. As Woodring (1959) has indicated, true *Cerithium* s.s., based on *C. adansonii* (= *C. erythraeonense*) is characterized by a flaring outer lip, a claw-like extension of the basal part of the outer lip projecting over the anterior siphonal canal, and a relatively long siphonal canal. These features are characteristic of some of the larger Indo-Pacific species such as *C. erythraeonense*, *C. nodulosum*, and *C. echinatum* but are not found in any of the western Atlantic *Cerithium* nor the Mediterranean species, *C. vulgatum*, the type-species of *Theridium*. Thus, all western Atlantic species fall under the sub-generic category of *Theridium*, provided one accepts this as a valid grouping. Mayr (1969) presented two criteria to be followed when considering the need for new taxa above the species level: 1.) an indication or clarification of a distinct phylogenetic relationship; 2.) usefulness as an information retrieval system. In light of this statement I can tentatively justify the retention of the sub-genus *Theridium* as a useful taxon pending more research on the

many other controversial sub-genera and genera that have been erected for the group commonly known as *Cerithium*.

Range. Worldwide; shallow water tropical and subtropical seas including the Mediterranean and Black Sea.

KEY TO THE WESTERN ATLANTIC SPECIES OF *CERITHIUM*

The following key is based on shell characters because these appear to be the most practical means of identifying species. *Cerithium* species are variable; consequently, the user should become familiar with as much material as possible before using the key. Important shell characters include axial ribs, spiral cords and nodes, siphonal and anal canal development, shell size and weight, and to some extent, color.

- 1 Shell with prominent axial ribs extending from the suture over the periphery onto the base 2
- 1 Shell with beaded cords and/or nodules but without distinct axial ribs 3
- 2(1) Spiral sculpture coarse, basal cord strongest, white with brown flecks, long siphonal canal, length to 26 mm *muscarum*
- 2(1) Spiral sculpture fine, lacking basal cord, color varying from a uniform cream to yellow and light brown with the lower portion of each whorl a solid, darker color; length to 45 mm *guinaicum*
- 3(1) Shell with strong sub-sutural nodules, anal canal large and flaring posteriorly; color cream with specks or blotches of tan; length to 34 mm *litteratum*
- 3(1) Shell with overall beaded sculpture; if nodules present then at periphery of whorl; anal canal not flaring 4
- 4(3) Body whorl rounded; spiral sculpture of numerous, nearly uniform beaded cords; anal and siphonal canals both short; color variable, usually uniform brown, but ranging to white; length 20 mm *lutosum*

- 4(3) Body whorl angled; spiral sculpture of varying coarse and fine or often nodulose cords; anal and siphonal canals prominent 5
- 5(4) Sculpture of 4-5 beaded to nodulose cords, the most prominent cord at the whorl periphery; nodes may become large and pointed at whorl periphery; spiral striae not crossing the nodes; length to about 40 mm *eburneum*
- 5(4) Sculpture of beaded or nodulose cords and fine spiral striae which cross the nodes; most prominent beaded cord and nodes between suture and middle of whorl; length to 50 mm *atratum*

ANATOMICAL NOTES

Accounts of the morphology and functional anatomy of the cerithiids are scattered and some of the more detailed literature on the anatomy of *Cerithium* tends to be confusing or inaccurate. Joannis (1834) published a brief account of the gross anatomy of *C. vulgatum*. Bouvier (1887) included some aspects of the general morphology of *Cerithium* in his comparative study of the nervous system of the Cerithiidae. In a discussion of the relationships between the Melaniidae and Cerithiidae, Sunderbrink (1929) dealt with the anatomy and histology of *C. vulgatum* in detail although some of his statements regarding the anatomy of the reproductive ducts are inaccurate. The anatomy of six species of *Cerithium* from New Caledonia and their relationships to other mesogastropods has been discussed by Risbec (1943, 1955). Johansson (1947, 1953, 1956) comprehensively surveyed the morphology and phylogeny of the pallial gonoducts of the Cerithiidae. The anatomy of *C. atratum* has received thorough morphological and histological treatment by Marcus and Marcus (1964), but it is difficult to correlate their statements regarding the reproductive tract with their figures. More recently, I have discussed the reproductive anatomy of the Indo-Pacific species, *Cerithium nodulosum* (Houbrick, 1971). In the present study, I have made general observations on the gross

anatomy of *Cerithium* species from various parts of the world.

Shell morphology:

Shells of the genus *Cerithium* are characteristically elongate, turreted, and somewhat slender. The aperture is ovate and there is a short, but well-defined, siphonal canal which is reflected. A moderately developed posterior canal is usually bordered with a columellar plica, defining an anal sulcus which extends well within the shell. The columella is normally straight and the outer lip may be smooth or moderately crenulate. The shells of many species are characterized by a sculpture of irregular spiral cords, which may be beaded or knobbed, occasionally giving a ribbed appearance. Shell structure, sculpture, and color are often variable. Protoconchs are small and normally lacking on adults due to erosion of the upper whorls. The operculum is ovate, paucispiral with an eccentric nucleus, generally thin, chitinous, and tan or brown. The periostracum is colorless and thin throughout the genus.

External morphology of body:

In many species of *Cerithium* the head-foot and pallial region have a gray or cream background color overlaid with many dark lines, blotches and white flecks, producing an overall effect of yellow-brown to olive-brown pigmentation. The foot is usually heavily pigmented above and lightly underneath. The body color of the head-foot and pallial region varies among species and, to a certain extent, within different populations of a single species. There is conspicuous iridescence in the pigmentation of the snout, tentacles and mantle edge.

The detailed description of the foot of *C. atratum* (Marcus and Marcus, 1964) may be applied in general to other species of *Cerithium*. It is short and thick, highly contractile and capable of considerable extension when the animal is in motion (f, Pl. 13). The anterior portion, the propodium, is heavily invested with mucus secreting cells

and is filled with a network of connective tissue and muscular fibers. The chitinous operculum (op, Pl. 13) is attached to the metapodium. The foot is innervated by nerves issuing from a pair of pedal ganglia situated at the juncture of the head-foot region. Two statocysts are closely associated with these ganglia by connective tissue innervated by the cerebral ganglia.

The head of *Cerithium* is broad with a prominent snout (sn, Pl. 13), which is longitudinally grooved or wrinkled and highly contractile. The odontophore is usually visible through the end of the snout. The mouth (m, Pl. 13), a semicircular slit bordered with disk-like labial ridges, is at the base of the inverted snout. The radula may be seen in the mouth when the animal is feeding. The tentacles (t, Pl. 13) are retractile and are moderately short in most species. Well developed eyes (e, Pl. 13) are found laterally on bulges at the extended bases of the tentacles in all *Cerithium* species and are innervated by an optic nerve arising from each

cerebral ganglion. In *C. atratum*, *C. litteratum*, *C. guinaicum* and *C. eburneum*, the eyes are quite prominent, ranging in color from dark brown to black and are surrounded by an iridescent orange pigment.

Mantle cavity and associated organs:

The dorsal and lateral edges of the mantle (me, Pl. 13) are characterized by the presence of highly pigmented pallial tentacles (pt, Pl. 13) or papillae. In the area of the incurrent siphon (in, Pl. 13) and to a lesser degree around the excurrent siphon (ex, Pl. 13) the mantle edge is modified into a muscular fold. The incurrent siphon is short and is innervated by the pallial nerve. Marcus and Marcus (1964) noticed a ciliated strip on the side of the foot associated with the excurrent siphon in *C. atratum*, but I have not seen it.

The mantle surrounds the head-foot region and is moderately thick at its edges, becoming progressively thinner posteriorly. Innervation is by nerves arising from the anterior

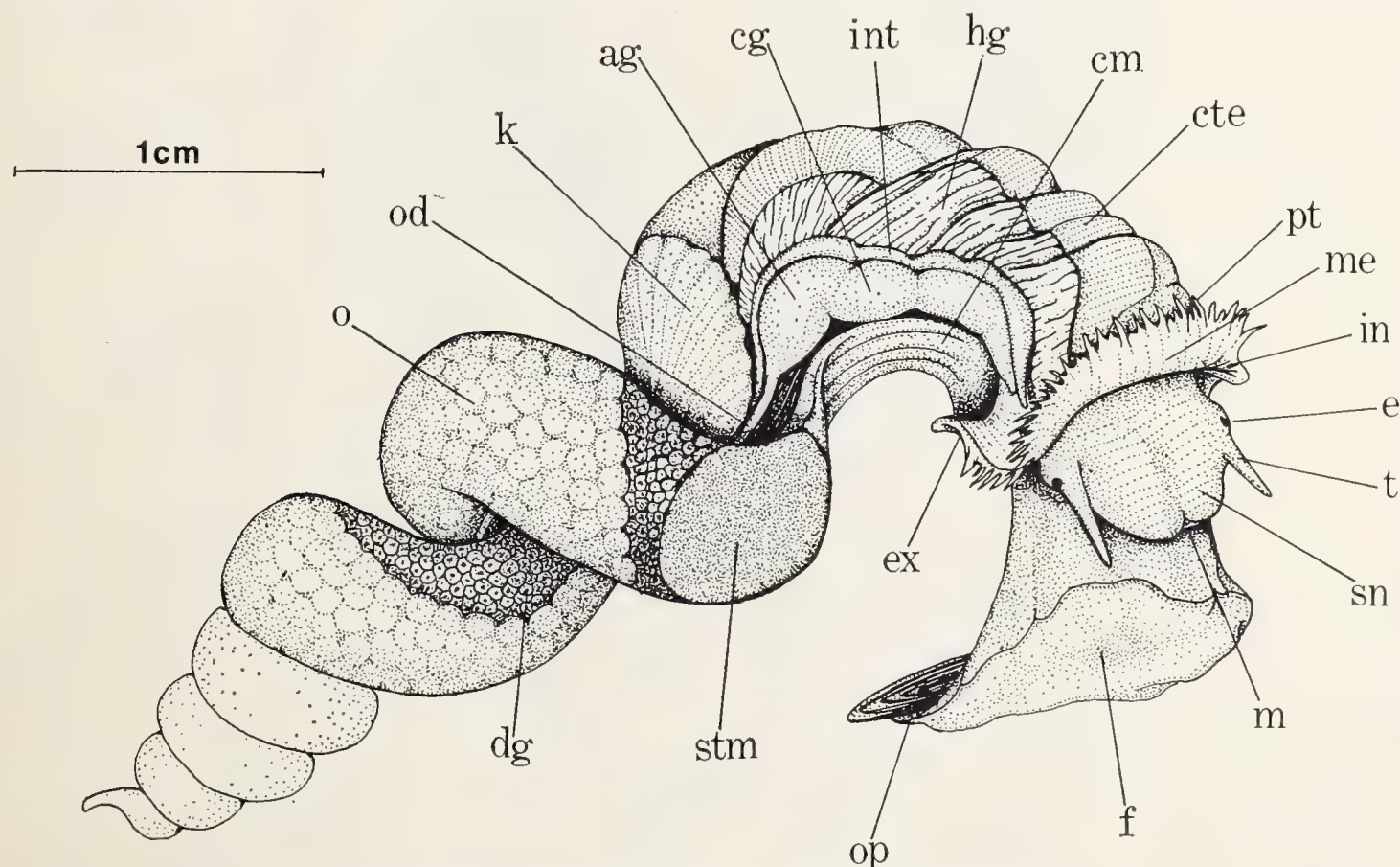


Plate 13. *Cerithium atratum* (Born), female with shell removed exposing mantle, visceral mass and associated organs.

portion of the cerebral ganglia. The mantle cavity is very deep due to the many whorls of the visceral mass and houses, from left to right respectively, the osphradium (os, Pl.

14), ctenidium (cte, Pls. 13, 14), hypobranchial gland (hg, Pls. 13, 14), intestine (int, Pls. 13, 14) and gonoducts (gd Pl. 14). The hypobranchial gland, ctenidium, and os-

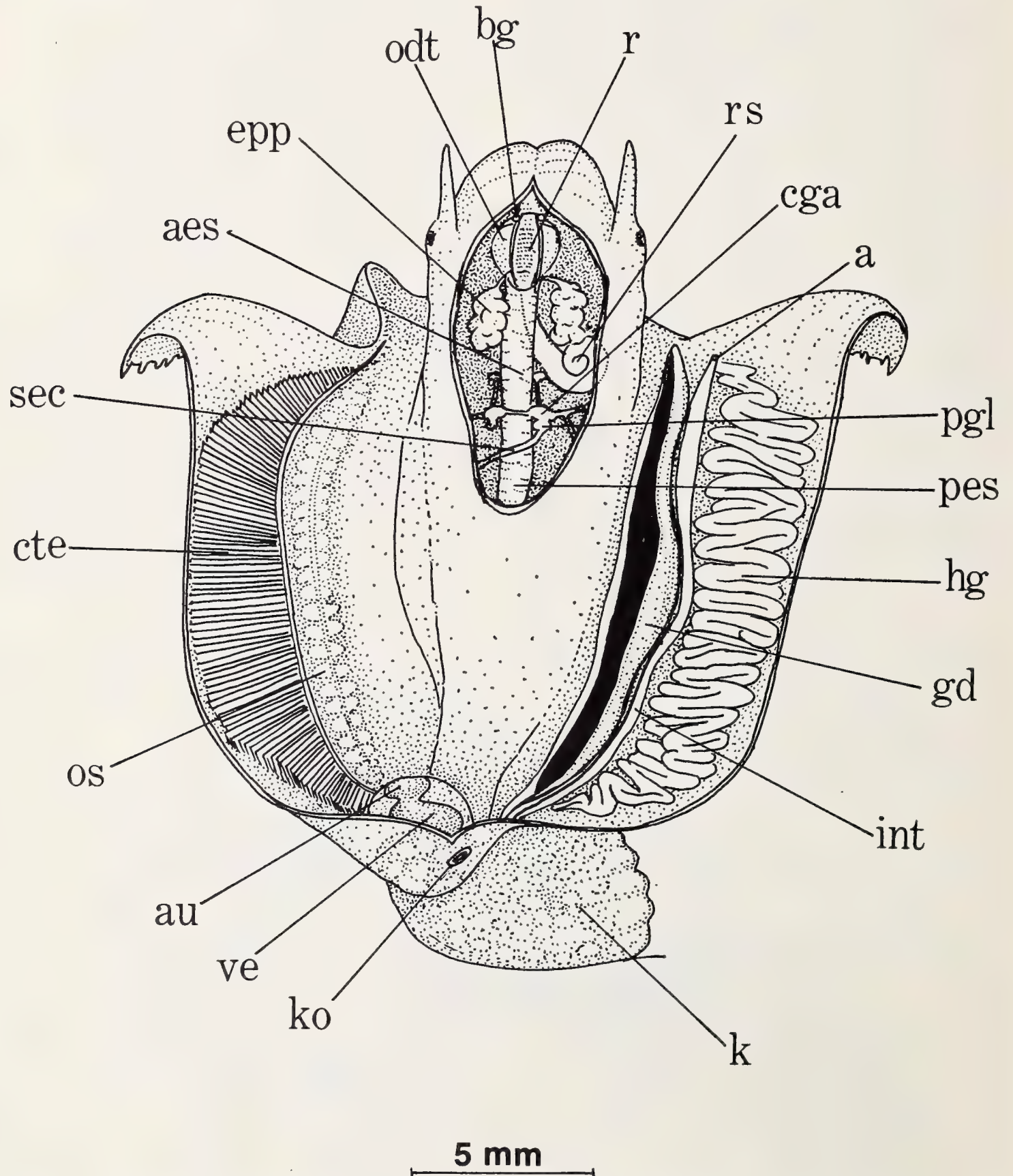


Plate 14. Generalized representation of *Cerithium* female. The mantle skirt has been medianly cut and the two halves deflected laterally. The buccal cavity has

been opened mid-dorsally exposing the anterior alimentary tract and nerve ring.

phradium are usually heavily pigmented while the gonoducts are a cream color. The osphradium is elongate and prominent, extending from the kidney-heart region (k, Pl. 14) anteriorly to the siphon. It is bipectinate and consists of triangular leaflets. A thick nerve from the supra-intestinal ganglion runs beneath the osphradium in *Cerithium* (Marcus and Marcus, 1964). The osphradium is separated from the ctenidium by a transparent region. The well-developed ctenidium is much longer than in other mesogastropods with perhaps the exception of the Turritellidae and the Vermetidae. It occupies a considerable portion of the mantle cavity and decreases towards the posterior of the cavity. Marcus and Marcus (1964) found mucus gland cells concentrated on the afferent border of each ctenidial leaflet in *C. atratum*.

The large, dull-green hypobranchial gland (hg, Pls. 13, 14), composed of loosely compacted material transversely folded, exudes copious amounts of mucus and breaks up easily in living animals rendering dissection difficult. Fixation frequently leaves the hypobranchial gland smooth which may account for Marcus and Marcus' (1964) description of a smooth gland in *C. atratum*. The description of the gland in *C. vulgatum* by Bouvier (1887) agrees closely with what I have seen.

The intestine (int, Pls. 13, 14) lying between the hypobranchial gland and the gonadal ducts, is normally filled with fecal pellets and sand grains. The anus (a, Pl. 14) is located close to the mantle edge.

Alimentary System:

The alimentary system of *Cerithium* is similar to that described for *Littorina* by Fretter and Graham (1962). The mouth (m, Pl. 13) opens into the buccal cavity. At its anterior end, the buccal cavity houses a pair of jaws embedded in the dorsal wall of the cavity and attached with connective tissue to the anterior part of the radular ribbon. The jaws, roughly triangular in shape, are thin transparent plates and may be edged

with tan or brown. The anterior portions of the jaws may be either smooth or covered with pegs (Marcus and Marcus, 1964) or saw-like teeth. Risbec (1943) has illustrated the jaws of several Indo-Pacific species. The buccal mass or odontophore (odt, Pl. 14) is muscular, red in color, and anchored dorsally to the body wall by strong muscles. A pair of buccal ganglia (bg, Pl. 14) lie embedded in the ventral floor of the buccal mass. The radula (r, Pl. 14) is typically taenioglossate (2-1-1-1-2), prominent, and runs over the median portion of the mid-dorsal surface of the odontophore. The median tooth bears a prominent middle cusp and two to three smaller ones. A triangular base in the lower middle part of the median tooth may be provided with a narrow medial and two lateral extensions which are usually difficult to see. The lateral teeth bear one strong inner cusp and 3-4 outer smaller ones. Triangular bases of the lateral teeth extend downward and fold inward, laterally. The two marginal teeth are long, narrow, and hook-like, bearing long inner cusps and several smaller outer ones. The number of cusps on the marginal and lateral teeth sometimes show variation within the same animal. The teeth of the anterior portion of the radular ribbon are often quite worn and appear much different from the newer, unused teeth further to the rear. Marcus and Marcus (1964) counted as many as 75 rows of teeth on the radular ribbon of *C. atratum*. At its rear, the radular ribbon projects ventrally at the opening of the esophagus into a radula sac (rs, Pl. 14) which lies under the esophagus and is usually coiled to the right. A pink, prominent, dumbbell-shaped radula-secreting gland is found at the blind end of the sac. The post-median retractor muscle is well-developed and prominent. There is no sexual dimorphism evident in radular characteristics.

The salivary glands are loosely compacted, small structures whose ducts pass through the nerve ring and discharge from the roof of the buccal cavity through openings located on

the ends of the dorsal folds of the esophagus. The salivary glands are not very large or extensively developed in most species of *Cerithium*.

The dorsal folds of the food channel of the anterior esophagus show a characteristic twist at the region of torsion just posterior to the nerve ring. Posterior to the nerve ring, the dorsal folds lie in the ventral portion of the posterior esophagus (pes, Pl. 14). This is typical for most prosobranchs.

The stomach is quite large, occupying almost one and a half whorls of the anterior visceral mass. The esophagus (es, Pl. 15) opens into the ventral side of the stomach. The intestine (int, Pl. 15) leaves at the anterior end in the style sac region (ss, Pl. 15) while the posterior end of the stomach is a blind sac. A large, complex sorting surface with many folds is found just anterior to the esophageal opening. Beyond this are two openings to the digestive gland (often re-

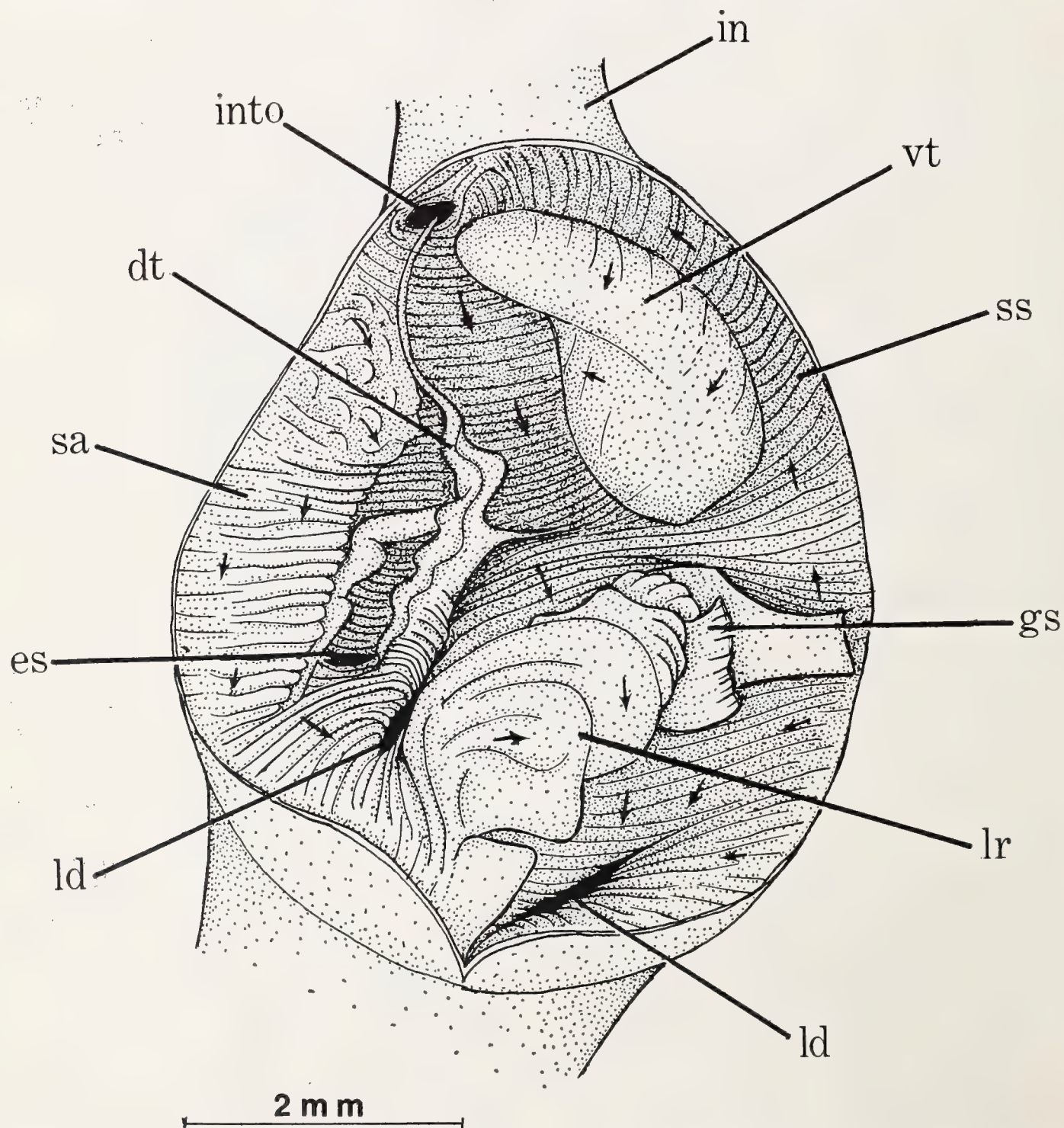


Plate 15. Stomach of *Cerithium atratum* (Born) opened by a dorsal longitudinal cut. Arrows indicate direction of ciliary currents.

ferred to as liver ducts) (ld, Pl. 15), which are separated by a broad cuticular ridge (lr, Pl. 15) arising from the ventral surface of the stomach. The edges of the right side of this cuticular area are free and curved, forming a pocket-like, much-folded sorting area. Anteriorly, the gastric shield (gs, Pl. 15) is attached to the cuticular area. Marcus and Marcus' (1964) description of this structure in *C. atratum* agrees closely with my observations. The style sac (ss, Pl. 15), containing a rather long transparent crystalline style, is anterior to the gastric shield. Styles have been observed in all *Cerithium* species covered in this study. Other authors have made the same observations on closely related genera such as *Cerithidea* and *Bittium* (Marcus and Marcus, 1964).

The dorsal and ventral typhlosoles (dt, vt, Pl. 15) lead into the intestine by way of the long style sac. Many ciliated folds and larger ridges which generate ciliary currents occur throughout the whole of the stomach. The stomach is often filled with algae, sand grains and detritus held together by a mucus string, especially in the area of the style. The long, tubular intestine extends from the style sac, loops beneath the stomach to the right side of the animal, and enters the mantle cavity. Sections show that it is filled with numerous ciliated folds along its inner walls. The string of fecal material becomes compacted into small oval fecal pellets which may be seen through the thin intestinal wall in dissected animals.

Reproductive System:

The genus *Cerithium* is dioecious and aphyllous rendering sexual determination difficult on the basis of external characteristics. Variation in the secondary sexual characteristics such as the gonadal ducts may occur within a population. Often the presence of trematodes alters the appearance of the gonads and their associated ducts and may be the cause of "parasitic castration." Outside of the breeding season the reproductive apparatus may become much reduced and in-

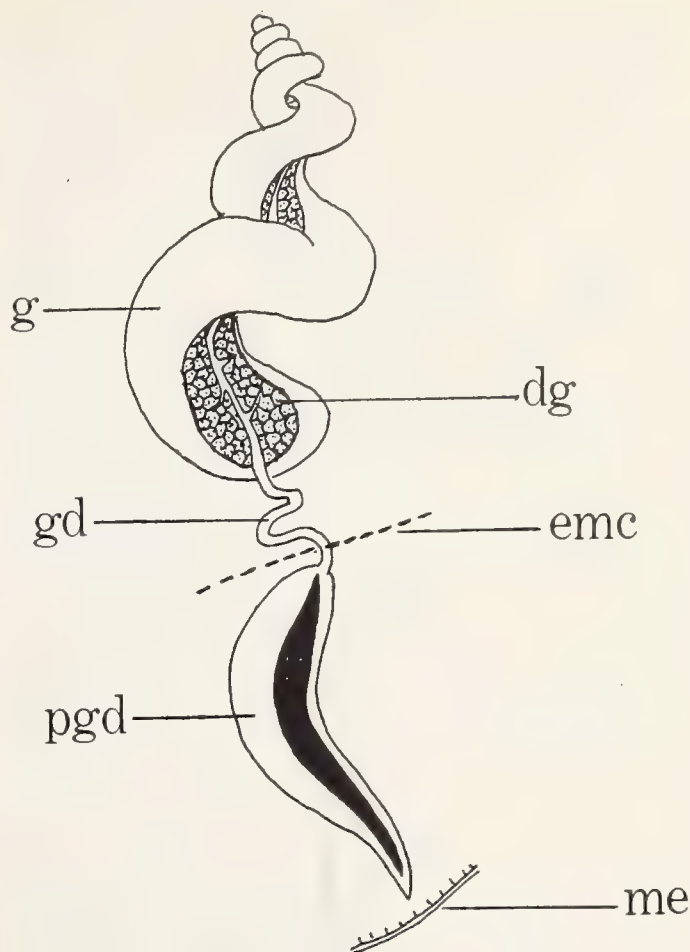


Plate 16. Generalized scheme of reproductive tract in the genus *Cerithium*.

significant. During the reproductive season, females may be separated from males on the basis of their swollen pallial gonadal ducts. Gonads (g, Pl. 16) are closely associated with the periphery of the digestive gland, making it difficult to separate the two. The ectodermal lining of the testes usually has a yellow-orange pigmentation. Testes are tubular. Each tubule opens into ducts which eventually connect and empty into the sperm duct. The sperm duct which lies coiled along the columella, is swollen during the reproductive season and acts as a vesicula seminalis, containing eupyrene and apyrene sperm. The sperm duct enters the mantle cavity in a pocket-like portion of the pallial genital groove. The genital groove or pallial gonoduct (pgd, Pl. 16) is open and consists of lateral (left) and medial (right) laminae which are fused dorsally to each other and to the mantle. The ventral margins are free and open to the mantle cavity. The proximal portion of the pallial genital groove is thick

and glandular and probably functions as a prostate. In *C. muscarum* the upper portion of the medial lamina is very thick, glandular, and opaque, and functions as a spermatophore organ. Homologous structures have been seen in the freshwater cerithiaceans, *Goniobasis* and *Pleurocera* (Woodward, 1934; Dazo, 1965). Beyond the prostate area the genital groove extends forward as a slit-like channel open to the mantle cavity. The epithelial lining of the inner walls of the laminae is thrown into numerous ciliated glandular folds which extend distally. These folds are not as highly developed as those of the proximal portion of the genital groove. This area is almost smooth in *C. nodulosum* and *C. lutosum*.

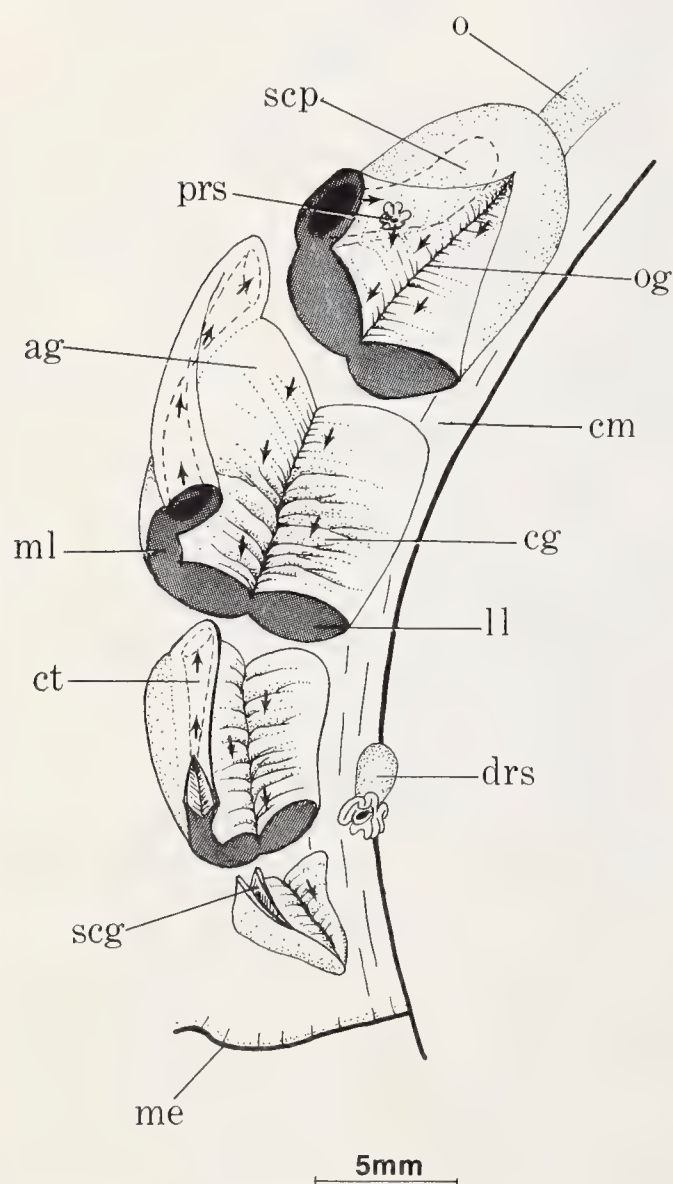


Plate 17. Diagrammatic representation of female pallial gonoduct and seminal receptacles in *Cerithium atratum* (Born).

The ovaries (o, Pl. 13) are usually a bright yellow color. During the reproductive period they are packed with ova in various stages of development. The oviduct (od, Pl. 13) is a closed tube leading into the proximal portion of the open pallial gonoduct. It, like the testis duct, closely follows the columella (cm, Pl. 13) on its route to the mantle cavity. Eggs are often found moving down the oviduct during the reproductive season. The general morphology of the female pallial gonoduct is similar to that described for males except that the laminae are larger, more glandular, and have a thinner, non-glandular portion along the edge of the medial lamina (ml, Pl. 17), which constitutes the albumen gland (ag, Pl. 17). The epithelial lining of the laminae may be heavily folded perpendicular to the groove, as in most species of the genus, or somewhat flat with little evidence of folds, as in *C. nodulosum* (Houbrick, 1971). Distal to the albumen gland is a glandular medial portion of the open gonoduct with thickly folded inner walls. This medial portion probably functions as a capsule gland (cg, Pl. 17). In this portion of the gonoduct the hyaline egg capsule is laid down around the zygote and the albumen coat. A short slit occurs at the distal end of the oviducal groove on the edge of the non-glandular portion of the medial lamina. This slit is the "sperm collecting gutter" (scg, Pl. 17) of Johansson (1953) and varies in length among the different species of *Cerithium*. The slit is long and deep in *C. lutosum*, *C. muscarum* and *C. atratum*, to short and shallow in *C. guinaicum* and *C. nodulosum*. The sperm collecting gutter leads into the opening of a long, ciliated, flattened tube (ct, Pl. 17) which runs inside the entire length of the non-glandular portion of the medial lamina (ml, Pl. 17), and enlarges into a spacious chamber at its proximal end. Within this pouch are found eupyrene sperm mixed with a yellowish-brown mucus and thin, resilient, jelly-like strands of unknown function. Johansson (1947) calls this area the

bursa copulatrix in *C. vulgatum*. I believe this is a poor term since there is, in a strict sense, no copulation in the genus. A better term would be sperm collecting pouch. Within this pouch (scp, Pl. 17) embedded in the wall of the inner portion of the medial lamina, is a glandular area (prs, Pl. 17) which varies in size and morphology among species. It is usually pink in color and has a warty, finger-like appearance in some species. This glandular area forms a flap, under which is a tiny opening leading through the wall of the lamina into the lumen of the proximal end of the pallial gonoduct. Ciliary currents lead from the sperm collecting pouch through the glandular area and its opening into the lumen. Examination of sections of fresh material from the gland reveal that it functions as a proximal seminal receptacle since oriented eupyrene sperm are found within the glandular pockets. The proximal portion of the lumen of the pallial gonoduct is where the unfertilized eggs leave the closed oviduct. Opposite the opening of the closed oviduct, on the body wall, is a heavily ciliated ridged area which is especially prominent in *C. luto-sum*. I believe that this is the site of fertilization and that sperm stored in the sperm collecting pouch are transported through the opening in the proximal seminal receptacle (prs, Pl. 17) and into the proximal open portion of the pallial gonoduct. Fertilization occurs as the eggs move into this proximal portion of the gonoduct after leaving the closed oviduct. After fertilization, albumen and the hyaline membranous capsule are laid down around the zygote as it continues to move along the open groove. Some species possess a pink glandular area at the distal end of the open gonoduct, opposite the slit on the medial lamina where the lateral lamina is fused to the dorsal body wall. Within this area is an opening leading to a thin tube or pocket filled with oriented eupyrene sperm. Johansson (1947) called this the seminal receptacle in *C. vulgatum*. I am calling it the distal seminal receptacle (drs, Pl. 17). It is

found just beneath the epithelium. I have seen this structure in *C. atratum*, *C. muscarum*, and *C. nodulosum* but have not been able to detect it in other species of the genus. It is difficult to understand the functional purpose of a seminal receptacle located in the distal portion of the open gonadal duct. Eggs reaching this area would already have been encapsulated and consequently fertilization would be impossible. Moreover, there are strong ciliary currents leading from the proximal to the distal portion of the grooved gonadal duct. It is difficult to imagine the sperm swimming against such a current from this distal seminal receptacle up to the site of fertilization. Perhaps sperm stored in the sperm collecting pouch shortly after copulation are moved out of the pouch via the aperture in the proximal receptaculum seminis, into the lumen and down the oviducal groove to the distal seminal receptacle where they are stored. During oviposition they may leave the distal seminal receptacle, be drawn into the ciliated slit on the medial lamina and move up into the pouch again where they are stored in the proximal seminal receptacle, prior to fertilization. The proximal seminal receptacle may thus function as a brief storage area for the sperm before they move through the aperture fertilizing the eggs before the latter have passed through the albumen and capsule gland areas. Eggs leave the mantle cavity and reach the exterior along a groove formed by the foot.

Excretory and Vascular Systems:

The kidney (k, Pls. 13, 14) in *Cerithium* is a moderately large, flat, spongy organ, usually gray or brown. It is easily located at the left side of the visceral hump. It may be divided into two portions which are nearly equal; one part on the right, bordering the pericardial cavity, and the left part, often a bit larger, consisting of many folds and lobes.

Risbec (1943) has noted the same arrangement and basic morphology of the kidney in the Indo-Pacific species of *Cerithium* which he studied at New Caledonia.

The kidney of *Cerithium* corresponds closely with the description of the prosobranch kidney as given by Fretter and Graham (1962).

The vascular system of *Cerithium* is also typical for mesogastropods and is composed of a two-chambered heart located in a pericardial cavity and a poorly defined open system of vessels and spaces. The pericardial cavity is located on the left side near the base of the visceral mass and consists of an anterior auricle (au, Pl. 14) and a posterior ventricle (ve, Pl. 14). The anterior aorta runs forward under the floor of the pericardial cavity dorsally to the left of the posterior esophagus and ends in a series of sinuses in the head-foot region. The posterior aorta branches off from the origin of the anterior aorta and runs along the outside of the visceral mass before emptying into the visceral sinuses. From these sinuses in the viscera and head-foot, blood is drained by collecting vessels into the kidney and then into the mantle and ctenidium before returning to the heart.

Discussion:

The anatomy of *Cerithium*, with the exception of the reproductive tract, is similar to other lower mesogastropods and corresponds with Fretter and Graham's (1962) detailed account of the anatomy of *Littorina*.

Cerithium have a crystalline style, and are characterized by possessing open pallial gonoducts. Morphological structures are generally homologous throughout the genus.

All who have worked on the anatomy of *Cerithium* have noted a similarity between the male and female reproductive systems, but there are strong differences between them, especially during the reproductive period. Healthy females have swollen, cream-colored pallial gonoducts and a filled seminal receptacle which easily separates them from males. During the period of the year when reproduction is not taking place, the albumen and capsule glands are inconspicuous in the female and the seminal receptacle is empty.

Females in this condition are not easily separated from males. The same conditions are observed in snails parasitized by trematodes, if the infestation has existed long enough. The similarity in structure and arrangement of the gonoducts in males and females has also been noted in the Pleuroceridae and it has been suggested by Woodard (1934) that this may point to a fairly recent hermaphroditic ancestry for this family. The Pleuroceridae have been called freshwater cerithiaceans by Morrison (1954), and both families may share a common ancestry. It is interesting to note that spermatophore organs as found in *C. muscarum* have also been described for the pleurocerid *Goniobasis*. The spermatophores are likewise similar (Houbrick, 1970). This, however, may be due to convergence.

The open gonadal ducts of *Cerithium* are similar to those described for other cerithiaceans such as *Bittium* (Johansson, 1947; Fretter and Graham, 1962), *Cerithiospis* (Fretter, 1951), and *Tympanotonus* (Johansson, 1956). Johansson's interpretation of the function of the chamber located in the outer portion of the medial lamina as a bursa copulatrix may be correct. However, the glandular area (proximal seminal receptacle) and its opening in the wall of chamber which leads into the lumen of the gonoduct were not mentioned by him. I have found these structures in all members of the genus that I have examined. Sperm entering the mantle cavity, after pairing of the snails, collect in the chamber and probably leave this area by traveling down the gonadal duct until they reach the receptaculum seminis at the distal end. During oviposition, sperm may leave the receptaculum, enter the sperm-collecting gutter, ciliated tube, and sperm-collecting pouch and eventually be stored in the other receptaculum located there. This places sperm in close proximity to unfertilized eggs entering the open duct from the closed oviduct.

The problem of the phylogeny of the open

pallial gonoducts of the Cerithiacea has been thoroughly discussed by Johansson (1947, 1953, 1956). He pointed out that the open glandular grooves with sperm collecting gutters along the edge of the oviducal folds occur in several families with different habits of life, e.g., the Turritellidae, the Cerithiidae, the Melaniidae and the Potamididae. Johansson believed that such open pallial gonoducts were primary characteristics of the group Cerithiacea and were ancestral recurrences of primitive grooves. Marcus and Marcus (1964) agreed with his interpretation. Fretter (1951) and Fretter and Graham (1962) did not agree, and suggest that the open condition of the ducts and the absence of a penis in these mesogastropods is correlated with a long, narrow mantle cavity. In such tightly coiled spires there is less space for the right half of the pallial complex. During the breeding season, with the swelling of the pallial oviduct in the female, the presence of a penis in the male and its insertion into the pallial oviduct during copulation would interfere with the efficient functioning of the mantle cavity. For this reason it is postulated by Fretter (1951) that the penis was lost and the sperm transferred to the female by a method involving open ducts, and I concur that the open condition of the duct in such mesogastropods is probably secondary and advantageous.

Cerithium (Thericium) litteratum (Born)

Plates 18-23

Murex litteratus Born 1778. Index. Mus. Caes. Vind., p. 327 (no locality given, refers to Lister, 1770, Hist. Conch., pl. 1024, fig. 89; type-locality, here designated, Key West, Florida; holotype, Natural History Museum, Vienna, Austria).

Murex literatus Born 1780. Test. Mus. Caes. Vind., p. 323, pl. 11, figs. 14, 15 [error for *litteratus* Born 1778].

Cerithium semiferrugineum Lamarck 1822. Anim. sans Vert., 7:74 (no locality given; syntype, MHNG 109/35); Reeve 1865. Conch. Icon., 15, *Cerithium*: Sp. 38, pl. 6, figs. 38,a,b; Kobelt 1898, Conch. Cab., 1, *Cerithium* (26): 143-144, pl. 27, figs. 6, 7.

Cerithium semiferrugineum Lamarck. Kiener, 1841, Coquilles Vivantes, 5, *Cerithium*: 43, pl. 4, figs. 5, 5a.

Cerithium angustum Anton 1839. Verzeichniss . . . Conchylien., p. 66, no fig. (no locality given; type not found).

Cerithium litteratum Born. Sowerby, 1865, [In] Reeve, Conch. Icon., 16: sp. 25, pl. 4, figs. 24, 25 (West Indies); Tryon, 1887. Man. Conch., 9: 128, pl. 22, figs. 63, 64; Kobelt, 1898. Conch. Cab., 1, *Cerithium* (26): 141-142, pl. 27, figs. 2, 3; Abbott, 1954. American Seashells, p. 154, pl. 19, 1; Abbott, 1958. Acad. Nat. Sci. Phila., Mongr. 11, p. 39; Warmke and Abbott, 1961. Caribbean Seashells, p. 72, pl. 13,o.

Cerithium literatum Born. [sic] Menke, 1830, Synop. Moll. p. 58; Smith, M., 1937. East Coast Marine Shells, p. 106, pl. 38, figs. 11a, b, c; Morris, 1951. A Field Guide to the Shells, p. 159, pl. 4, fig. 6 (the figure is not *C. litteratum*); Rice and Kornicker, 1962. Pub. Inst. Mar. Sci., 8: 371, pl. 2, fig. 2.

Cerithium litteratum playagrandensis Weisbord 1962. Bull. American Paleont., 17 (193): 170-172, pl. 15, figs. 1, 2 (Pliocene-Recent, Playa Grande formation (Maiquetia member), Venezuela; holotype, Paleontological Research Institute, Ithaca, N.Y.).

Cerithium litteratum (Born). Abbott, 1968, Seashells of North America, pp. 88, 89, fig. 7; 1970. Coastal Brazilian Seashells, pp. 42, 43, pl. 9.

Cerithium litteratum semiferrugineum Lamarck. Rios, 1970, Coastal Brazilian Seashells, p. 43, pl. 9.

Description. Shell reaching 34 mm in length, stout, stubby, heavy. Whorls, 8-9, variable in structure and ornamentation. Protoconch usually missing or eroded. Basic sculpture of numerous fine spiral threads; normally with a distinct subsutural row of 9-12 sharp prominent nodules forming an angulated shoulder and often a second smaller row of nodules (spines) on the periphery of the whorls though both may be weak or absent. There are frequently beaded and crenulated cords on the base of the shell, the cord a short distance below the periphery of the last whorl being the largest. Body whorl usually flattened or concave, near the parietal side. Usually a weak varix opposite the outer lip. Aperture oval, columella and outer lip with heavy enamel-like callus; outer lip frequently thick flaring; projecting forward and strongly crenulated. Siphonal canal deep, short and reflexed; anal canal deeply excavated and well-defined, bordered on the parietal wall with a distinct columellar plica which defines the deep anal sinus and extends well within the shell. Color variable, usually

whitish, finely maculated with brown to black spots. Heavy-shelled forms sometimes entirely orange-yellow or with larger brown blotches. Operculum tan-brown, corneous, ovate and paucispiral with a well-defined eccentric nucleus. Periostracum not evident. Radula 2-1-1-1-2; cusps on rachidian and lateral teeth sharp, prominent. Animal usually maculated with brown or black, especially on head, mantle and upper part of foot. Gonadal ducts open, no anterior receptaculum. Reproduction oviparous; egg mass a tangle of filamentous threads; each capsule contains a single ovum; development with planktotrophic veliger stage.

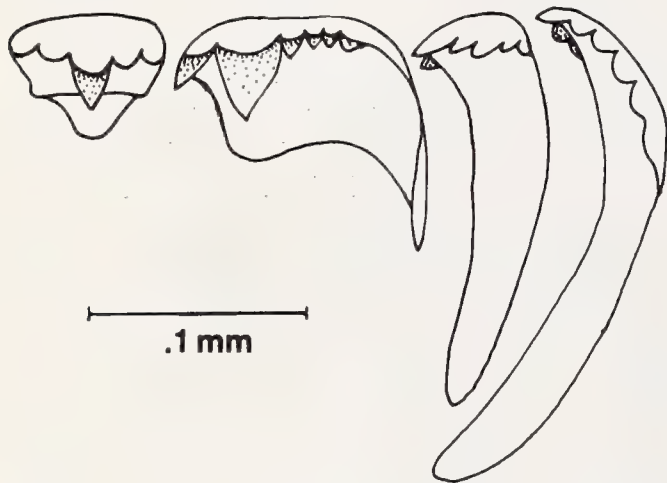


Plate 18. *Cerithium litteratum* (Born) from Boca Raton, Florida. Radula, half-row.

length	width	no. whorls	
34 mm	15 mm	8	Bermuda
31	16	8	Cabo Catoche, Yucatán, Mexico
31	13	9	Lyford Cay, Bahamas
27	12	8+	Bahía Honda Key, Florida
25	11	8	Carrie Bow Cay, British Honduras
23	11	8+	Dry Tortugas, Florida
20	11	8	Jupiter Inlet, Florida
19	8	8+	St. Thomas

Remarks. The heavy, stubby shell, spiral row of nodules just beneath the sutures, and the prominent posterior canal are the distinguishing characters of this species. *Cerithium litteratum* is found subtidally in shallow water around coral reefs and on algal-covered rocks and rubble, occurring to depths of 35 fms. It is one of the larger Atlantic *Cerithium* species. A population at Boca Raton,

Florida spawned during June and July and veligers hatched from the egg capsules in 3-4 days (Houbrick, 1974c). D'Asaro (1969) suggested that *C. litteratum* probably spawns throughout the year. Egg masses are stringy structures, typical of other species with planktotrophic veligers (Pls. 19, 20). The life span of populations in Florida is estimated at one year (Houbrick, 1974b). The Boca Raton population ate algae and detritus; the dominant alga in stomach contents were *Enteromorpha* and *Chaetomorpha*.

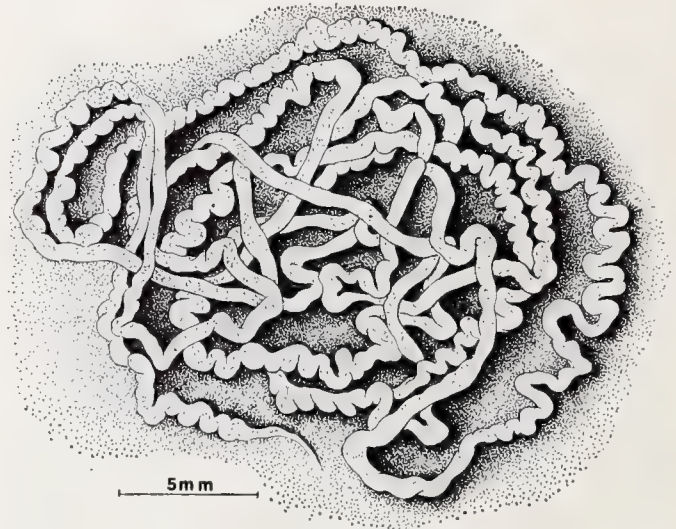


Plate 19. Egg mass of *Cerithium litteratum* (Born) from Soldier's Key, Dade Co., Florida. Egg mass is deposited on sand (courtesy of Prof. Gunnar Thorson).

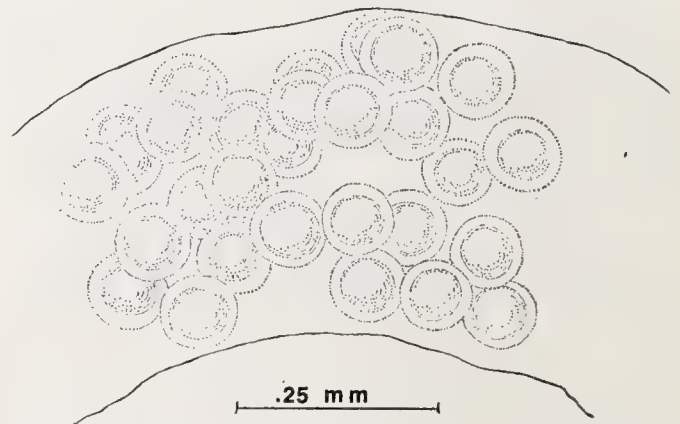


Plate 20. Portion of filament from egg mass of *Cerithium litteratum* (Born) from Soldier's Key, Dade Co., Florida. Encapsulated zygotes are contained within (courtesy of Prof. Gunnar Thorson).

Born's original reference to Lister may constitute a misidentification and is unclear. Lister's (1685) small figure is a poor illustration and could apply to any *Cerithium* species with a nodulose sculpture. The species of Born was clarified in 1780 when he published an excellent figure of his type speci-

men. The holotype of *C. litteratum* is in the Vienna Museum (Pl. 21, figs. 3, 5, 6). The original and correct spelling of the specific name has 3 "t's" although some recent authors have followed Born's 1780 rendering of it, *Cerithium literatum*.

Cerithium semiferrugineum Lamarck is merely a morph of *C. litteratum*. I have examined a photograph of Lamarck's type from Geneva and it is clearly *C. litteratum*. Both Kiener (1841) and Reeve (1865) noticed a similarity between Lamarck's species and *C. litteratum*. Reeve noted that the shells of *semiferrugineum* were smoother between the ridges than *C. litteratum* and that the coloring was laid on in irregular patches. Sowerby's (1865) figure of *C. semiferrugineum*

clearly demonstrates its close resemblance to *C. litteratum*. The "semiferrugineum" forms (Pl. 22) occur throughout the range of *C. litteratum*, from Bermuda to Brazil, and do not constitute a sub-species, but merely a genetic or ecological variety with many intergrades. These morphs are usually found in deeper water around coral reefs. They are heavy-shelled, highly polished, and have fewer spiral cords, more prominent and fewer nodules, and are characterized by bright coloration, most often yellow or orange with darker patches of brown.

Anton's (1839) *Cerithium angustum* was placed into the synonymy of *C. litteratum* by Tryon (1887), Mörch (1876), Kobelt (1898), and Weisbord (1962). I have been

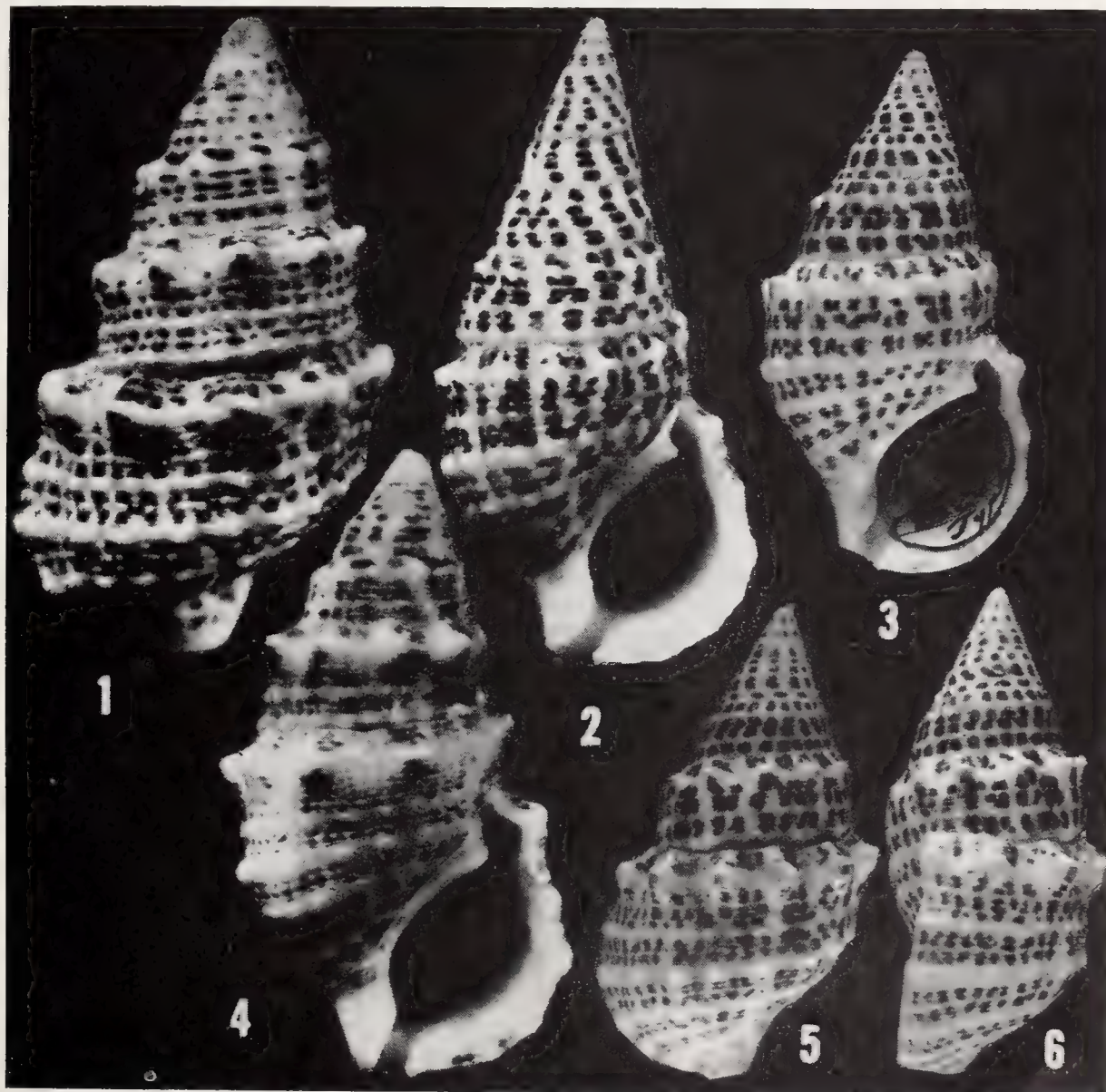


Plate 21. *Cerithium litteratum* (Born), typical forms. Fig. 1. Key Largo, Florida (36.1 mm); Fig. 2. Plantation Key, Florida (24 mm); Figs. 3, 5, 6. holotype, Vienna

Museum (no locality given, 30 mm); Fig. 4. Boca Raton, Florida (36.1 mm).

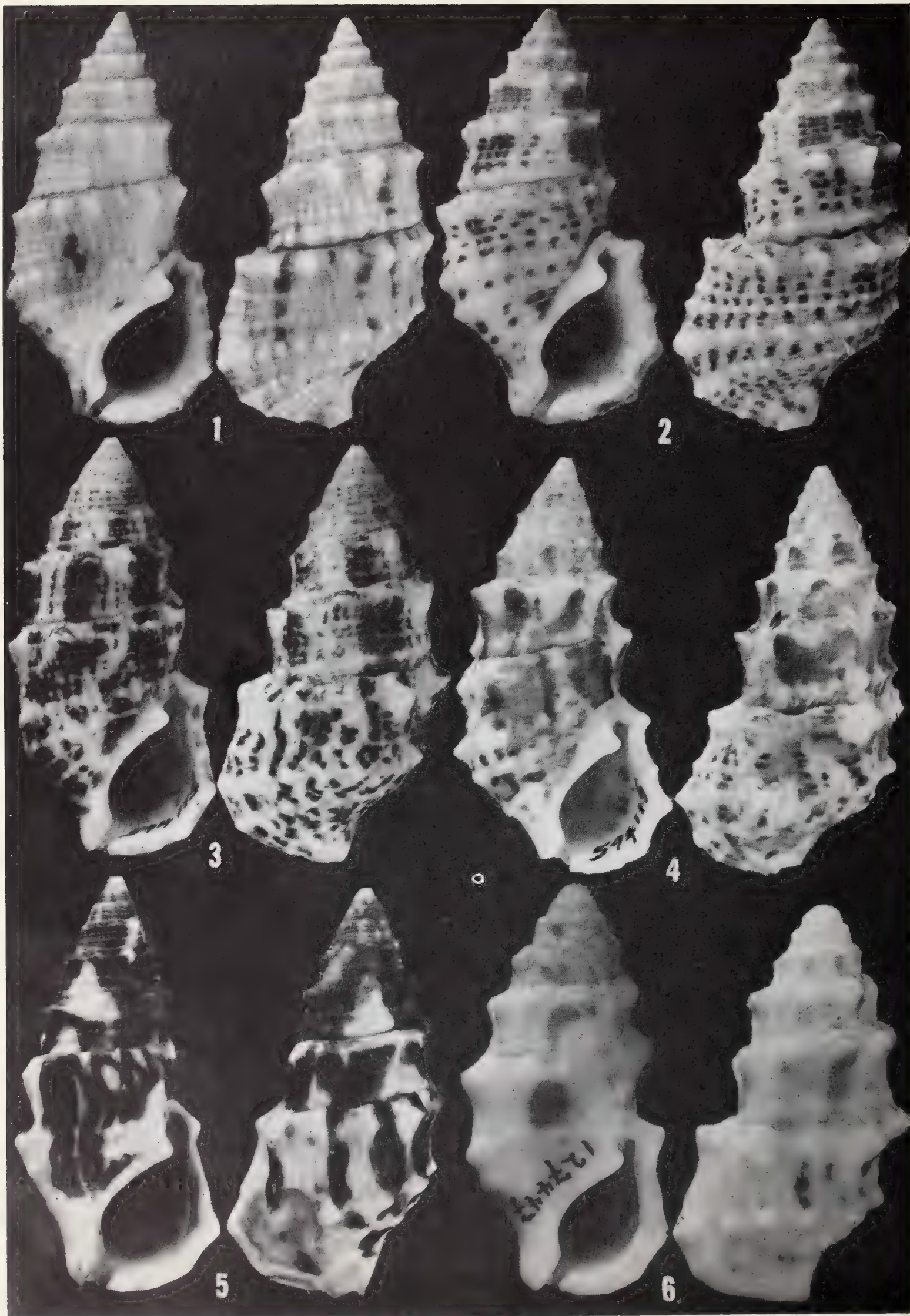


Plate 22

unable to locate Anton's type and there is no figure given with his original description, but it appears to conform to what is understood as *C. litteratum*. Kobelt mistakenly placed *C. pictum* (*Murex pictus* Wood) [= *C. guinaicum* Philippi] in the synonymy of *C. litteratum*.

Little difficulty is encountered in separating *C. litteratum* from other Western Atlantic species. Problems may arise in assigning the "semiferrugineum" forms to the species if one is not aware that intergrades (Pl. 22, figs. 1, 2, 3) exist. Typically, *C. litteratum* has a whitish base color and is spotted with brown or black (Pl. 21, figs. 1, 2, 4). Although the deep posterior canal and spiral row of nodules just below the suture are the distinguishing features of the species, there is much variation and some specimens may be almost smooth. Variations in shell sculpture, size and color may occur both within and between populations.

Recent descriptions and illustrations of *C. litteratum* may be found in Abbott (1954) and Warmke and Abbott (1961). The specimen figured by Morris (1951) as *C. litteratum*, is *C. atratum* (Born).

Fossil record. *Cerithium litteratum* is known to occur in the Pleistocene (Weisbord, 1962). The subspecies, *C. litteratum playagrandensis*, described from the Pliocene of Venezuela by Weisbord (1962), is here placed into the synonymy of *C. litteratum*; the great variation in Recent forms precludes the erection of a subspecies on the basis of one specimen. *C. litteratum* also occurs as a fossil in Bermuda (Peile, 1926). Weisbord (1962) has discussed the relationship of Recent and Pleistocene *C. litteratum* with other fossil species. Mansfield (1930) suggested that the Miocene species, "*Cerithium*"

harveyensis Mansfield, from the Florida Choctawhatchee Formation, was related to *Cerithium litteratum*. Some specimens of *C. russelli* Maury (1917) look similar to Recent *C. litteratum* and may be ancestors. Valenciennes (1832) believed that the Panamic *C. stercusmuscarum* resembled *C. litteratum*, but they are easily separated on the basis of shell color and form and do not appear to be related.

Range. Bermuda, the Bahamas and from offshore S. Carolina to eastern Florida; occasionally in southwestern Florida; offshore banks and reefs in the northwest, west, and southern parts of the Gulf of Mexico, and throughout the entire Caribbean region, south to eastern Brazil. Depth range to 48 fms.

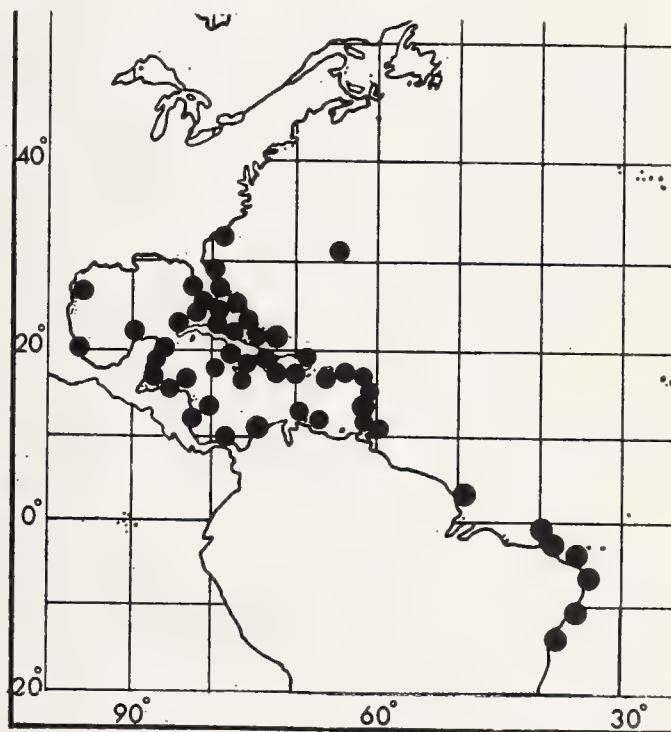


Plate 23. Geographical distribution of *Cerithium litteratum* (Born).

Specimens examined. SOUTH CAROLINA: 46.5 mi. 130° off Sandy Point, Racoon Key in 35 fms. (MCZ). FLORIDA: New Smyrna Beach (LACM); St. Lucie Inlet (AMNH); Peanut Island, Lake Worth (USNM); Lake Worth (both UMML); Palm Beach Inlet; Hillsboro (LACM); Boca Raton (USNM); Ft. Lauderdale (DMNH); Soldier Key, Biscayne Bay (USNM); Bear Cut, Key Biscayne (UMML); Cape Florida (UMML); Key Largo (UMML, AMNH); Upper Matecumbe Key (USNM); Long Key (COP); Grassy Key (AMNH); Angelfish Key (AMNH); Loggerhead Key (USNM); Garden Key, Dry Tortugas (USNM); Ft. Myers (AMNH); Tampa Bay (LACM). TEXAS: West Flower Garden

Plate 22. *Cerithium litteratum* (Born), coral reef or "semiferrugineum" morphs. Fig. 1. Aruba (34.9 mm); Fig. 2. St. Croix, Virgin Islands (30 mm); Figs. 3-4. Matanzas, Cuba (35 mm and 34 mm); Fig. 5. Sint Maartin (35.2 mm); Fig. 6. New Providence Island, Bahamas (31 mm).

Bank at 44 m. in N W Gulf of Mexico (Parker & Cur-ray, 1956). MEXICO: Vera Cruz (COP); Isla de Mujeres, Quintana Roo (ANSP); Esirito Santo Bay, Quintana Roo (USNM). BRITISH HONDURAS: Carrie Bow Cay; Long Cay, Glover's Reef (both USNM). HONDURAS: Cayo Utila (USNM). NICARAGUA (LACM). PANAMA: Colón (USNM); Man o' War Cay, Puerto Bello. BERMUDA: S W Reef off Somerset; Hungry Bay, Paget Parish (both USNM). BAHAMAS: E end of Grand Bahama Island (AMNH); Long Island, Great Abaco (ANSP); Cotland Cay, Great Abaco; Bimini Lagoon, Bimini (both AMNH); Mangrove Cay, Bimini (USNM); Nassau, New Providence Island (AMNH, USNM); Savannah Sound, Eleuthera (AMNH); Spanish Wells, Eleuthera (USNM); Andros Town, Andros Island (AMNH); Hurricane Harbour, Norman Cay, Exuma Chain (USNM). CUBA: Cayo Hutia Reef, Pinar del Río (USNM); Rosario, Havana (UMML); Carbeneras, Mantanzas; Camarioca, Matanzas (both AMNH); Ensenada de Maya, Matanzas (USNM); Nispero, Santiago de Cuba, Oriente (AMNH); Jardines de la Reina, Camagüey (ANSP). JAMAICA: Ochos Ríos (USNM); Pedro Bank (UMML); Montego Bay; Kingston (both AMNH). HAITI: Port-au-Prince (AMNH); Little Reef, Petit Goâve (USNM). DOMINICAN REPUBLIC: Barahona; Trujillo, inside Yuncu Reef; 5 mi. E of Jimani (all AMNH). PUERTO RICO: Turamato, Laguna; Guanica Harbor; Roosevelt Roads; Gata Island (all AMNH). LESSER ANTILLES: St. Thomas (ANSP); Mary's Creek, St. John's (UMML); Teague Bay (USNM); Frederiksted, St. Croix (COP); St. Martin (ANSP); Guadeloupe (ANSP); Cocoa Point, Barbuda; Freeman's Bay, English Harbour, Antigua; Pigeon Island, St. Lucie (USNM); Tobago (AMNH). CARIBBEAN ISLANDS: Grand Cayman (AMNH, ANSP); Cayman Brac (AMNH); Santa Marta Bay, Curaçao (AMNH); Bonaire (USNM, AMNH); Aruba; Los Roques (both ANSP); Albuquerque Cays (UMML); Swan Islands (USNM); San Andres Island (LACM); Iron Wood Point, Old Providence Island (AMNH). COLOMBIA: Cartagena (USNM, ANSP); Santa Marta (ANSP). VENEZUELA: Bahía Mochima (USNM). BRAZIL: Fortaleza (Matthews, 1967); off Amapá in 48 fms.; off Maranhao; off Paraiba in 40 fms; off Maceió in 17 fms.; Itaparica (all Rios, 1970).

Cerithium (*Theridium*) *atratum* (Born)

Plates 24-29

Murex atratus Born. 1778. Index Mus. Caes. Vind., p. 329 (no locality given; type-locality, here designated as Guadeloupe; holotype and paratype in Natural History Museum, Vienna); 1780, Test. Mus. Caes. Vind., p. 324, pl. 11, figs. 17, 18.

Cerithium atratum Bruguière 1792. Encyc. Method. Hist. Natur. Vers., pp. 480, 481.

Cerithium atratum Bruguière. Kiener, 1841, Coquilles Vivantes, 5, *Cerithium*: 33, pl. 10, fig. 5; Orbigny, 1841, Voyage dans l'Amérique méridionale, 7: 444.

Cerithium atratum Born. Sowerby, 1855, Thes. Conch., 2: 856, pl. 179, fig. 69; Reeve, 1865. Conch. Icon., 15, *Cerithium*: sp. 32, pl. 5, fig. 32; Kobelt, 1898. Conch.

Cab., 1, *Cerithium* (26): 192-193, pl. 35, figs. 4, 5; Tryon, 1887. Man. Conch., 9: 128, figs. 68-70; Smith, M., 1937. East Coast Marine Shells, p. 106, pl. 38, fig. 15; Nicklès, 1950. Manuels Ouest-Africains, 2: 24, fig. 76; Marcus and Marcus, 1964. Bull. Mar. Sci. Gulf Caribbean, 14(3): 496-497; Rios, 1970. Coastal Brazilian Seashells, p. 42, pl. 9.

Cerithium caudatum Sowerby 1855. Thes. Conch., 2: 856, pl. 179, figs. 71, 72. (Guadeloupe; syntypes, BM(NH) 1907-10-28-104-5); Reeve, 1865. Conch. Icon., 15, *Cerithium*: sp. 16, pl. 3, fig. 16.

Cerithium umbonatum Sowerby 1855. Thes. Conch., 2: 859, pl. 180, fig. 95. (Jamaica; syntypes, BM(NH), not catalogued).

Cerithium striatissimum Sowerby 1855. Thes. Conch., 2: 856-857, pl. 180, figs. 86, 87 (no locality given; holotype, BM(NH) 1907-10-28-157).

Cerithium graciliforme Sowerby 1865. [In] Reeve, Conch. Icon., 15, *Cerithium*: sp. 49, pl. 8, fig. 49 (no locality given; composite species; syntypes, BM(NH) constitute a mixed lot of *C. atratum* and *C. eburneum* Bruguière; lectotype here selected BM(NH) [not catalogued], length 33.4 mm).

Cerithium floridanum Mörch 1876. Malak. Blätt., 23: 114 (Sarasota Bay, Florida; no figure; types lost); Dall, 1890. Trans. Wagner Free Inst. Sci. Phila., 3(2): 282, pl. 14, fig. 10; Smith, M., 1937. East Coast Marine Shells, p. 106, pl. 38, fig. 7; Perry, 1940. Bull. Amer. Paleont., 26(95): 131, pl. 27, fig. 194; Abbott, 1954. American Seashells, p. 153, pl. 19,n; Perry and Schwengel, 1955. Marine Shells of the Western Coast of Florida, p. 142, pl. 27, fig. 194; Abbott, 1968. Seashells of North America, pp. 88, 89, fig. 6; Rios, 1970. Coastal Brazilian Seashells, p. 42, pl. 6.

Cerithium subatratum Kobelt 1898. Conch. Cab., 1, *Cerithium* (26): 193, pl. 35, figs. 6, 7. (Florida; holotype, SMF 228105).

Cerithium floridanum leonensis Mansfield 1930. Fla. State Geol. Surv., 3: 97, pl. 13, figs. 1, 4 (Upper Miocene; Harvey's Creek, Leon Co. Florida; syntypes, USNM 370275, 370276).

Cerithium algicola C. B. Adams. M. Smith, 1937, East Coast Marine Shells, p. 105, pl. 38, fig. 10 [non *C. algicola* C. B. Adams].

Cerithium floridanum March [sic]. (=Mörch). Morris, 1951. A Field Guide to the Shells, p. 158-159, pl. 32, fig. 4 (fig. 4 constitutes a mixture; shell to right is *C. muscarum* Say).

Cerithium (*Theridium*) *floridanum* Mörch. Olsson and Harbison, 1953. Acad. Nat. Sci. Phila., Mongr. no. 8, p. 282, pl. 42, fig. 1; Andrews, 1971. Seashells of the Texas Coast, pp. 78, 79 with fig.

Cerithium (*Theridium*) *peratratum* Olsson and Harbison 1953. Acad. Nat. Sci. Phila., Mongr. no. 8, p. 284, pl. 42, fig. 3 (St. Petersburg, Florida; holotype ANSP 18634).

Cerithium (*Theridium*) *atratum* (Born). Olsson and Harbison, 1953. Acad. Nat. Sci. Phila., Mongr. no. 8, pp. 283-284, pl. 42, figs. 4, 4a.

Cerithium (*Theridium*) *vicinia* Olsson and Harbison 1953. Acad. Nat. Sci. Phila., Mongr. no. 8, pp. 282-283,

pl. 42, fig. 2 (St. Petersburg, Florida; holotype, ANSP 18633).

Cerithium algicola C. B. Adams. Warmke and Abbott, 1961. Caribbean Seashells, pl. 13, p. (is *C. atratum*); Rios, 1970. Coastal Brazilian Seashells, p. 42, pl. 9. (is *C. atratum*), non C. B. Adams.

Cerithium floridanum Mörch — var. *cruzana* [sic] Usticke 1959. Check List of Marine Shells of St. Croix, pp. 38-40, pl. 2, fig. 16. (St. Croix; holotype in Usticke collection); Usticke, 1968. A supplementary listing of new shells, p. 11, pl. 2, fig. 355. Private publication.

Cerithium atratum (Born). Rios, 1970. Coastal Brazilian Seashells, p. 42, pl. 9.

Description. Shell reaching 50 mm in length, solid, spire elongate with an acute apex; protoconch usually eroded or missing. Adult specimens usually with 10-13 whorls; sutures moderately defined. Sculpture of 4-5 primary spiral cords ornamented with 18-20 beads or 8-11 nodes. 5 primary spiral cords usually on last whorl; sutural and second spiral cords most nodular and prominent; the fifth frequently bifid, and a sixth finely beaded cord may be present on base. Between primary spiral cords there is an overall pattern of fine spiral threads and incised lines. Incised lines overrun the primary spirals and nodes. Aperture obliquely ovate, constricted both above and below; columella usually with strong callus. Siphonal canal of medium length, reflexed; anal canal well-developed, defined by a fold at upper part of columella

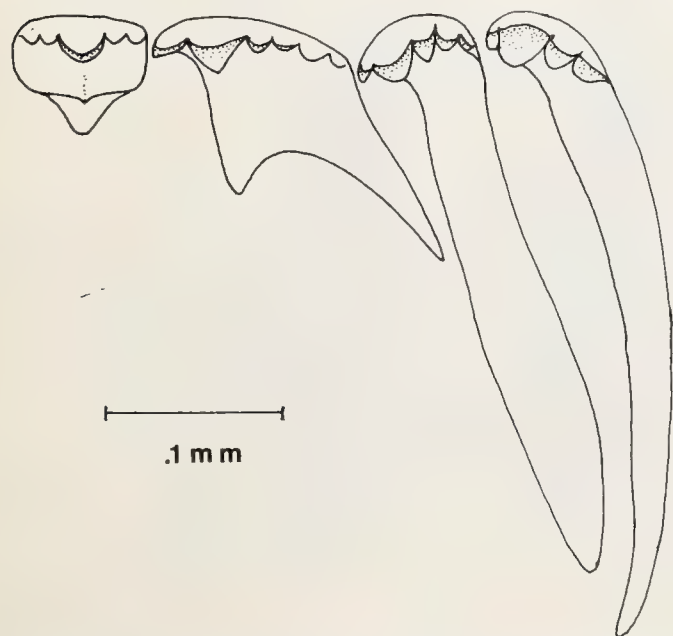


Plate 24. *Cerithium atratum* (Born) from St. Joseph Sound, Dunedin, Florida. Radula, half-row.

forming a strong sinus which extends well within the aperture. Outer lip thick, crenulate. Color variable, ranging from dark brown to cream-white with chestnut markings. Operculum corneous, ovate and paucispiral with a well-defined eccentric nucleus. Periostracum not evident. Radula 2-1-1-1-2. Animal white with chestnut-brown markings most prominent on upper portions of head and foot; mantle beneath shell usually orange. Gonadal ducts open, reproduction oviparous; egg mass consisting of long twisted, tangled filaments; each capsule containing a single ovum; development indirect with a planktotrophic veliger stage. Larval shell granulate.

length	width	no. whorls	
50 mm	17 mm	12+	St. Thomas
47	14	13	Panama City, Florida
42	15	12	St. Augustine, Florida
39	16	11	Bahia, Brazil
37	12	11	St. Lucie, Florida
34	13	11	Nueva Esparta, Venezuela
25	8	10	Vera Cruz, Mexico
21	8	10	Boca Raton, Florida

Remarks. This species is distinguished by its large, elongate shell, its sculpture of 4-5 beaded or nodular cords and the fine spiral striae which cross the nodes; the most prominent beads and nodes are on the cord between the suture and the middle of the whorl.

Cerithium atratum is the largest and most variable of the western Atlantic *Cerithium* species and has an extensive range, attaining an amphi-Atlantic distribution. It is likewise found in a variety of habitats ranging in its vertical distribution from the intertidal to subtidal zones and occurring on sand, rock, and alga substrata. It lives in quiet, sheltered bays or estuarine areas, in sea grass communities, and in coral reef habitats. A population in St. Joseph Bay, Dunedin, Florida was found just below the low tide mark where it burrowed in calcareous sand. This population was observed feeding on detritus and algae such as *Enteromorpha*. Oviposition

occurred from March through July. Egg masses were attached to rocks and covered with sand grains. The egg masses consisted of stringy masses of filaments forming knot-like clusters; one mass was estimated to contain 32,000 eggs. Hatching of the veligers occurred in 3-4 days. Veligers have tan-colored shells (Houbrick, 1974, c). Thorson's (in litt.) observations on the eggs of this species in west Africa are similar (Pl. 25, a-c).

Examination of museum collections reveals considerable geographic variation as well as intrapopulation variation. Because of the genetic and ecological variation in size, color and sculpture of the shell, there has been a great deal of confusion about the identity of this species. Marcus and Marcus (1964) discussed the nomenclatural difficulties surrounding *C. atratum* but suggested only a tentative synonymy.

Born's original description is vague and lacks type-locality and figure, but in 1780 he published two figures which help to give us an idea of his species. Examination of the holotype and paratype of *C. atratum* at the Vienna Museum shows them to be identical with other dark-colored specimens from the Antilles and Brazil (Pl. 26, fig. 4). Kiener (1841) mistakenly referred *C. atratum* to Bruguière; his figure is also very much like the melanistic forms of this species from the Caribbean. Kiener was the first author to cite the "Antilles, Guadeloupe, et celles du Bresil" as localities. Sowerby (1855) erroneously cited Sicily as the habitat of *C. atratum*, but his figure clearly matches those of Born and Kiener. Reeve (1865), Tryon (1887) and Smith (1890) suggested that *C. caudatum* Sowerby, 1855, from the island of Guadeloupe, was a synonym of *C. atratum*, and having examined Sowerby's syntypes

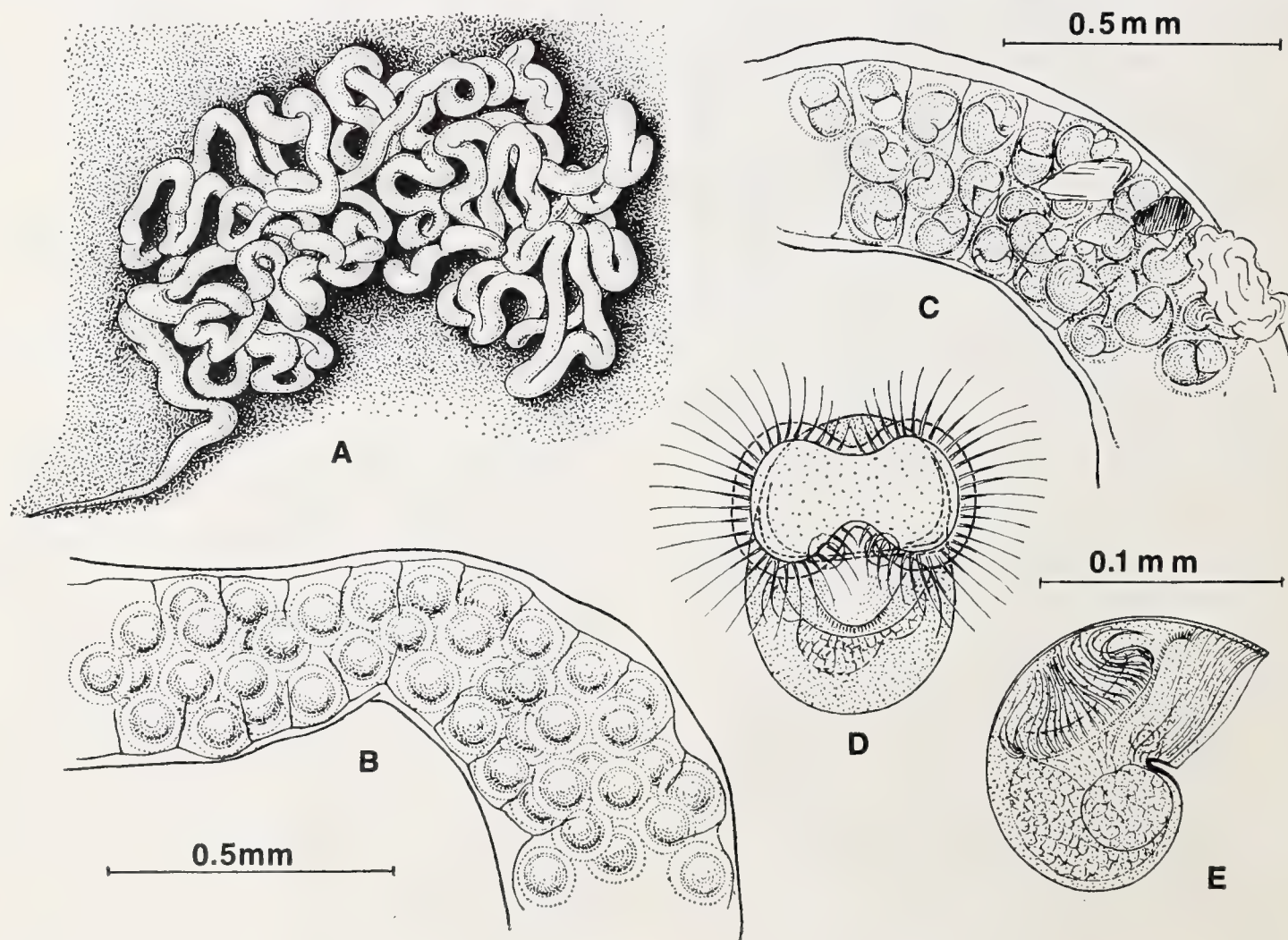


Plate 25. Egg mass and veligers of *Cerithium atratum* (Born) from Conakry, Guinea. A. Egg mass containing about 1900 eggs (total length 49.5 cm); B. Portion of egg

mass filament with zygotes; C. Larvae ready to hatch; D. and E. Free-swimming veligers, just hatched. Larval shells are granulate (courtesy of Prof. Gunnar Thorson).

(Pl. 26, fig. 3), I am in agreement with them. I also consider Sowerby's (1855) *C. umbonatum* (Pl. 26, fig. 2) and *C. striatissimum* (Pl. 26, fig. 1) to be synonyms of *C. atratum*.

Cerithium striatissimum has a smooth, beaded shell, very similar to the morph described by Mörch (1876) as *C. floridanum*. *Cerithium graciliforme* Sowerby, 1855, is based upon syntypes which constitute a mixed

lot of *C. atratum* and *C. eburneum*. A lectotype is here selected BM(NH) [no reg. no.]; length 33.4 mm. Mörch (1876) described a smooth, beaded form of *C. atratum* from Sarasota, Florida, naming it *C. floridanum* but he never illustrated it. Mörch began his description of *C. floridanum* with the words, "Differs from *C. atratum* . . .", and cited *C. caudatum* as a synonym of his

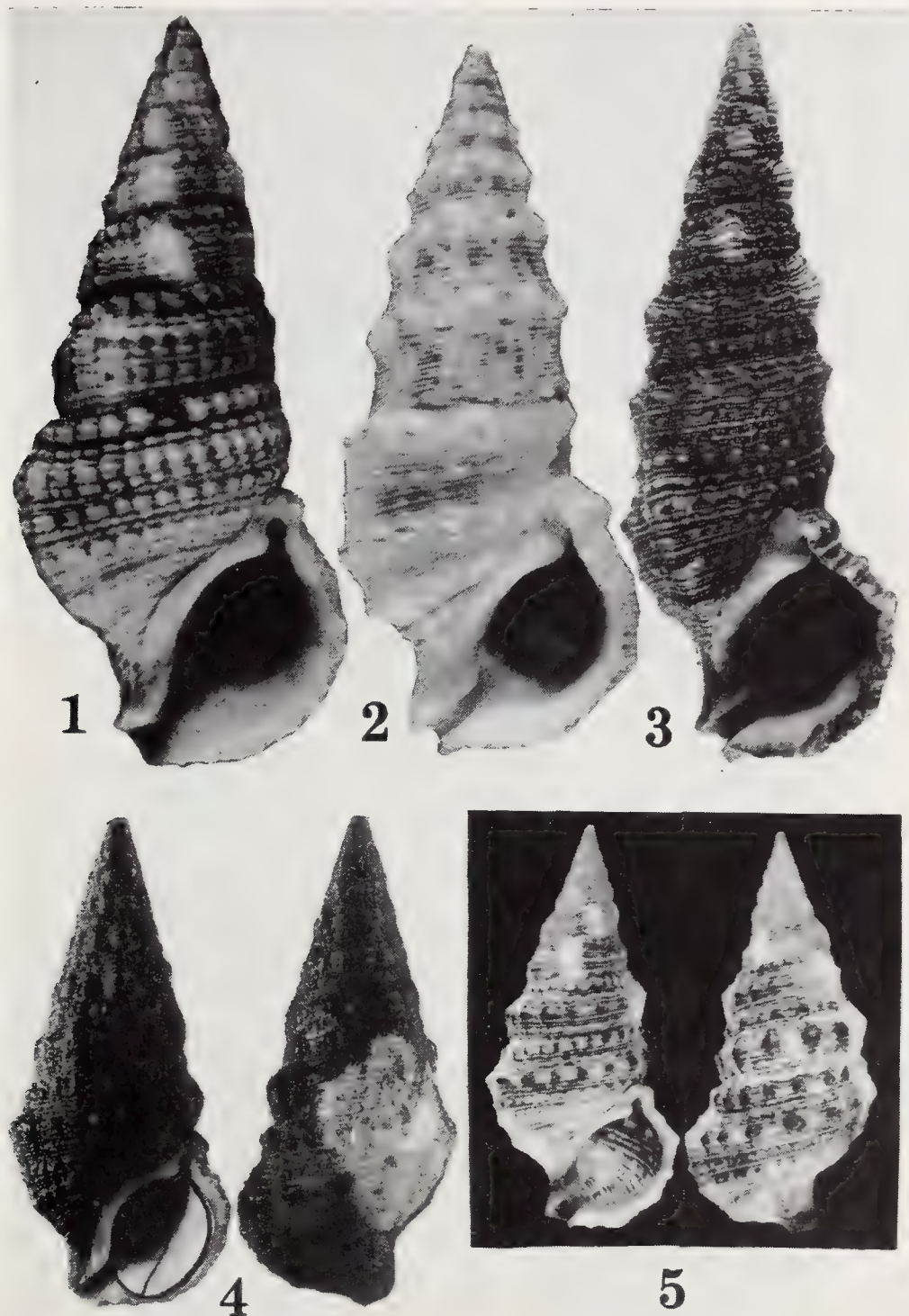


Plate 26. *Cerithium atratum* (Born). Fig. 1. *C. striatissimum* Sowerby, holotype BM(NH) 1907-10-28-157 (no locality given, 26 mm); Fig. 2. *C. umbonatum* Sowerby, syntype BM(NH), Jamaica (39.6 mm); Fig. 3. *C.*

caudatum Sowerby, syntype BM(NH) 1907-10-28-104-5, Guadeloupe (38.1 mm); Fig. 4. holotype, Vienna Museum, (no locality given, 27 mm); Fig. 5. *C. subatratum* Kobelt, holotype, Senckenberg Museum, (23.7 mm).

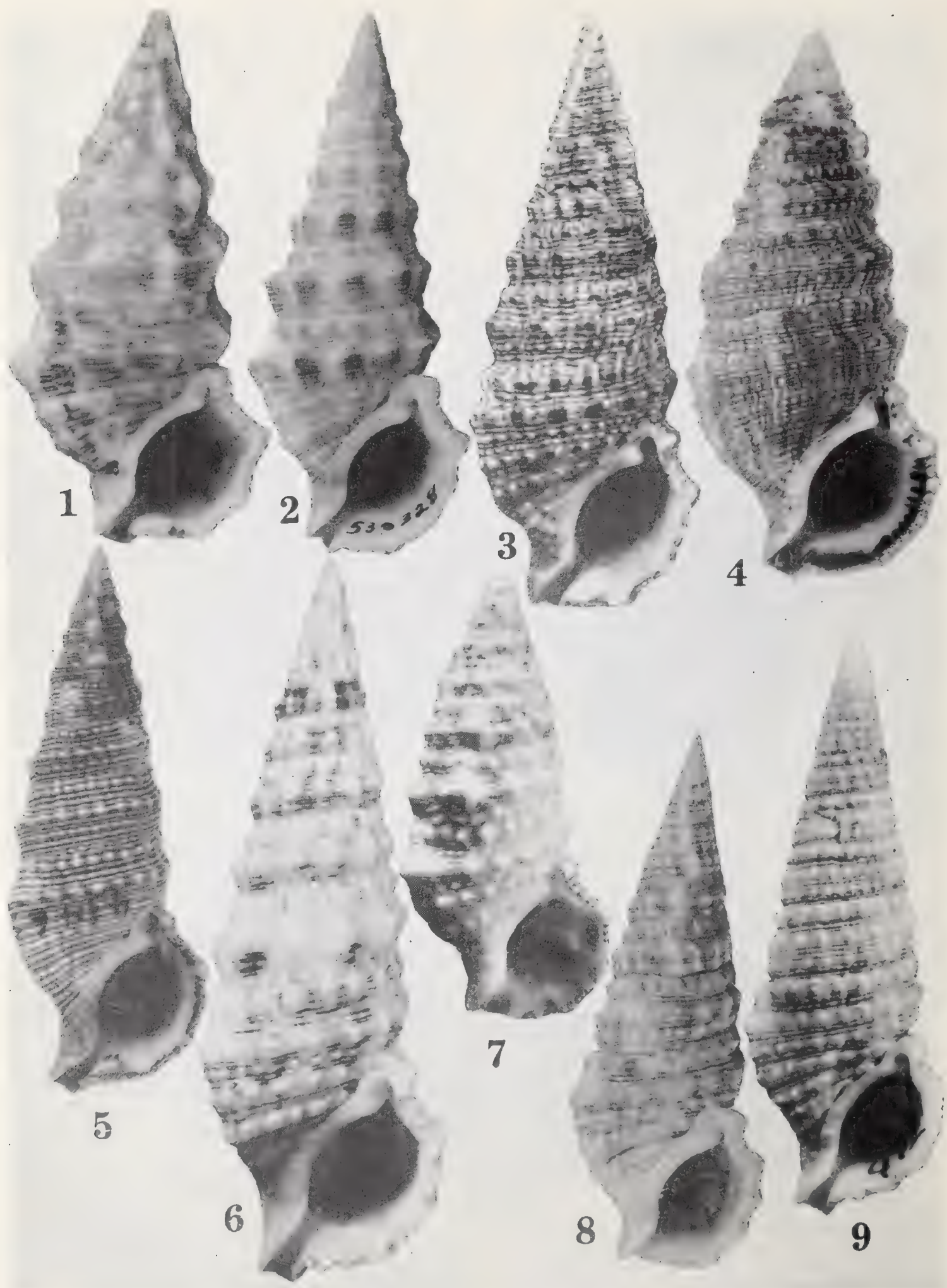


Plate 27

species. A museum search has not turned up the missing type material. *Cerithium floridanum* is the name most frequently encountered in recent literature for *C. atratum*, but usually refers to specimens from Florida and the shallow waters of the Gulf Coast. Recent figures and descriptions of *C. atratum*, given under the name *C. floridanum*, appear in Olsson and Harbison (1953), Perry and Schwengel (1955), Abbott (1954), Rios (1970), and Andrews (1971). Examination of extensive material from all parts of the Atlantic indicates that intergrades between smooth, beaded (Pl. 27, figs. 5, 8, 9) and extremely knobby morphs (Pl. 27, figs. 1, 2, 7) exist throughout the range of *C. atratum*. In museum collections it is impossible to separate many lots of Mörch's morph, (*C. floridanum*), from *C. atratum*, especially those from the Caribbean. Tryon (1887) was the first to suggest that *C. floridanum* was a synonym of *C. atratum*; Dall (1890) and Perry and Schwengel (1955) noted its close resemblance to *C. algicola* (= *C. eburneum*). There has been some confusion in separating *C. floridanum*, *C. atratum* and some knobby morphs of *C. eburneum* (Marcus and Marcus, 1964), especially those from coral reef habitats (Pl. 27, figs. 1, 7).

Shells from Sarasota Bay, Mörch's type-locality for *C. floridanum*, are generally of a beaded, smooth appearance (Pl. 27, fig. 9). This is also true for most other inshore populations from the Gulf coast of Florida. However, offshore populations in the Gulf of Mexico and an inshore population at Panama City, Florida, (Pl. 27, fig. 6), take on a very nodulose or spiny character and are more darkly colored. Populations from Stu-

art (Pl. 27, fig. 3), Jensen Beach, St. Lucie Inlet (Pl. 28), and Palm Beach on the east coast of Florida are of a darker color and vary considerably in sculpture, ranging from typical smooth morphs, as found in Sarasota, Mörch's type-locality, to specimens with spinose nodes identical to Born's *C. atratum*. I have also seen this phenomenon of intergradation in populations from Cienfuegos, Cuba; Montego Bay, Jamaica; Limon, Costa Rica; Puerto Bello, Panama; Bahia, Brazil, and St. Paul de Loanda, Angola. It is possible that there may be hybridization between other species and *C. atratum*, but the intergrades at the intrapopulation level seen in extensive museum collections indicate that we are dealing with a single variable species. Moreover, the various forms of *C. atratum* occur throughout its range and preclude any subspecific taxa. Olsson and Harbison (1953) illustrated *C. atratum* and placed the specimen of *C. floridanum* illustrated by Perry and Schwengel (1955, pl. 27, fig. 194) under their concept of *C. atratum*. Olsson and Harbison's (1953) *C. peratratum* is merely an intergrade between forms of *C. atratum* and morphs like Mörch's *C. floridanum*. These authors also described the Pliocene *C. vicina* on the basis of minor sculptural details and noted that recent specimens had been determined as either *C. floridanum* or *C. atratum*. After examining the type material, I have placed it in the synonymy of *C. atratum*.

Kobelt (1898) described a variation of *C. atratum*, naming it *C. subatratum*. His species differs from *C. atratum* only in minor sculpturing details and a photograph of the holotype (Pl. 26, fig. 5) clearly indicates that it should be considered a synonym of *C. atratum*. Kobelt designated Florida as the type-locality, but Zilch (in litt.) said that the label accompanying the holotype, and written by Kobelt himself, indicated that the species was collected by Ruppell in the Red Sea. This places Kobelt's species in greater doubt, but the label may be a mistake.

Plate 27. *Cerithium atratum* (Born), showing variation in shell form. Fig. 1. Boca Raton, Florida (19.5 mm); Fig. 2. St. Thomas, Virgin Islands (50 mm); Fig. 3. Stuart, Florida (38.5 mm); Fig. 4. Maceio, Brazil (37.8 mm); Fig. 5. Jamaica (38 mm); Fig. 6. Panama City, Florida (47.8 mm); Fig. 7. Sand Key, off Key West, Florida (32.4 mm); Fig. 8. St. Joseph Sound, Dunedin, Florida (38 mm); Fig. 9. Sarasota Bay, Sarasota, Florida [type-locality] (37.2 mm).

Several recent publications reflect the confusion surrounding the identity of *C. atratum*. Morris' (1951; pl. 32, fig. 4) figures of *C. floridanum* (= *C. atratum*), constitute a mixture; the shell on the right is *C. muscarum*. The shell illustrated by Warmke and Abbott (1961; pl. 13, p) as *C. algicola* is *C. atra-*

tum. The shells illustrated by Rios (1970) as *C. algicola* are *C. atratum*.

Fossil record. *Cerithium atratum* occurs from the Caloosahatchee Pliocene of Florida (Heilprin, 1887; Dall, 1890). *Cerithium coccides* Dall, from the St. Petersburg Pliocene appears to be related; this similarity was

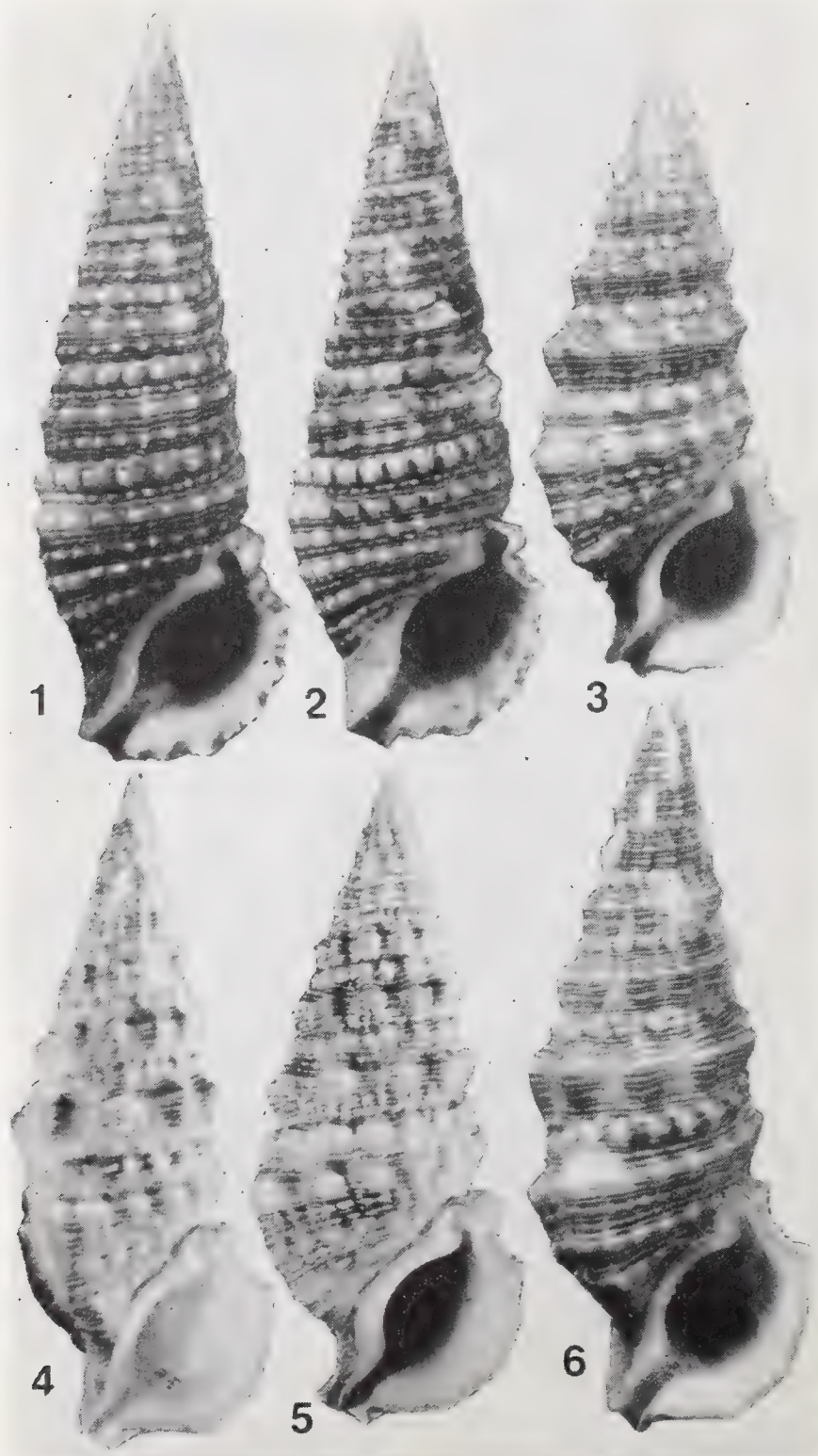


Plate 28. *Cerithium atratum* (Born). Representatives of a population from St. Lucie Inlet, Florida showing gradations from smooth to knobby morphs. Fig. 1. (39.2 mm); Fig. 2. (42.3 mm); Fig. 3. (37 mm); Fig. 4. (36 mm); Fig. 5. (39.1 mm); Fig. 6. (33 mm).

commented upon by Olsson and Harbison (1953). McGinty (1970) listed *C. atratum* (under the name *C. floridanum*) as occurring in the "Glades" unit of southern Florida. Mansfield (1930) described a Pliocene subspecies, *C. floridanum leonensis*, from central Florida. Heilprin (1887) pointed out that *C. atratum* was a markedly variable species and suggested that his *C. ornatissimum* bore a general resemblance to it and to *C. eburneum*. Specimens of *C. costaricensis* Olsson, 1922 and *C. dominicense* Gabb, 1873 look similar to Recent *C. atratum*. I concur with Maury (1917), who noted that *C. russelli* Maury, a species from the Dominican Republic, resembled Recent species of *C. atratum* which she found on beaches on the same island.

The Recent Panamic species, *C. uncinatum* (Gmelin, 1791) is virtually indistinguishable from *C. atratum* and is probably the Panamic cognate of the latter. Dall (1890) made the latter a synonym of *C. uncinatum*. I strongly suspect that this Panamic species is a subspecies of *C. atratum*, but more material is needed for comparison. Another Recent Panamic species, *C. nicaraguense* Pilsbry and Lowe, 1932, also closely resembles *C. atratum*.

Range. *Cerithium atratum* has the most extensive range of all Atlantic *Cerithium* species. Eastern Atlantic: Cape Blanc, Mauritania south to Angola. Western Atlantic: North Carolina south to Florida and the Bahamas and throughout the Gulf of Mexico, throughout the Caribbean south to São Paulo, Brazil; Fernando Noronha Islands (Smith, 1890). Depth range to 50 fms.

Specimens examined. WESTERN ATLANTIC; NORTH CAROLINA: Beaufort (MCZ; ANSP). Cape Lookout Bight; Middle Sound, Wilmington; 53 mi. E. Cape Fear, Hanover Co.; Pelican Station 184-7 in 9 fms. (all USNM). SOUTH CAROLINA: 43¼ mi. off Sandy Point, Racoon Key (MCZ); 44 mi. ESE Bulls Id., Charleston. FLORIDA: 35 mi. ENE Mayport, Pelican, 15 fms.; 12 mi. E. Fernandina, Pelican, 9 fms. (both USNM); Fernandina Beach (AMNH); St. Augustine (MCZ; ANSP; LACM); New Smyrna Beach; Ft. Pierce (both MCZ); Stuart; St. Lucie Inlet (both USNM); Jupiter Inlet;

Boynton Beach (both MCZ); Riviera Beach (USNM); Singers Island, Lake Worth (UMML); Boca Raton; Port Everglades; Sand Key, Key West (all USNM); Cape Florida; Dry Tortugas (both AMNH); Marco Pass (UMML); Naples (ANSP); Sanibel Island (AMNH; USNM; ANSP); Punta Gorda (AMNH); Sarasota Bay; Point o' Rocks, Sarasota (both USNM); Lido Beach; Bradenton Beach (both AMNH); Osprey, Manatee Co. (ANSP); Sunshine Causeway, St. Petersburg (AMNH); Tampa Bay (ANSP; COP); Dunedin; Tarpon Springs; Anclote Key (all USNM); N. Anclote Channel; Destin; Crystal Beach (all ANSP); Rabbit



Plate 29. Geographical distribution of *Cerithium atratum* (Born).

Key, off Chokoloskee (AMNH); Indian Pass, Apalacheicola (USNM); Ft. Walton (MCZ); West jettie, Panama City (USNM). TEXAS: Port Isabel (MCZ). MEXICO: Vera Cruz, Villa del Mar; Chenkan, Campeche; Isla del Carmen, Campeche (all MCZ). BRITISH HONDURAS: Stann Creek; Glover's Reef (both USNM). COSTA RICA: Portete (USNM). PANAMA: Brujas Point; Cristobal (both MCZ); Galeta, Colón (AMNH); Colón (ANSP). BAHAMAS: N. Bimini, Eolis Station, 50 fms. (USNM); Nassau (AMNH). CUBA: Cayo Hutia Reef, Pinar del Rio (USNM); Rosario, Havana (UMML); Carbeneras, Matanzas; Camarioca, Matanzas (both AMNH); Ensenada de Maya, Matanzas (USNM); Nispero, Santiago de Cuba, Oriente (AMNH); Cienfuegos, Las Villas (USNM); Jardines de la Reina, Camagüey (ANSP). JAMAICA: (USNM). HAITI: Miragoâne; Cape Haïtien; Anse à Maissons; Île Grande Cayamite (all MCZ). DOMINICAN REPUBLIC: Barahona (AMNH); Santa Barbara de Samana (MCZ); San Lorenzo Bay (ANSP). PUERTO RICO: Cayo Enrique, ½ mi SE of Magueyes, La Parguera (MCZ); San Juan (USNM). LESSER ANTILLES: St. Johns (USNM); St. Thomas (ANSP); Cape E. Reef, Martinique; Guadeloupe (both AMNH); St. Martin (ANSP); Chaguaramas, Trinidad; Barbados (both MCZ). CARIBBEAN ISLANDS: Aruba (ANSP). COLOMBIA: Cartagena (ANSP; USNM). VENEZUELA: Nueva Esparta

(USNM); Guante (ANSP). BRAZIL: Fortaleza; Pernambuco (both MCZ); Maceió, Alagoas (USNM); Mar Grande, Isla Itaparica (MCZ); Bahia (COP); Campos; Rio de Janeiro (both MCZ); San João Barra, E. Rio (ANSP); Isla São Sebastiao (MCZ); São Paulo; Natal Bay (both AMNH). EASTERN ATLANTIC: SIERRA LEONE: Lakka Beach (MCZ); Murray Town (both MCZ). LIBERIA: Cape Palmos (MCZ). TOGO: Lomé (AMNH). RIO MUNI: Adje, 20 mi. S. of Benito (MCZ). ANGOLA: St. Paul de Loanda; Lobito (both AMNH).

Cerithium (Theridium) eburneum

Bruguère

Plates 30-33

Cerithium eburneum Bruguère 1792. Encyc. Method. Hist. Natur. Vers., 2: 498, no fig. (Guadeloupe; lectotype here designated, Geneva Museum 1097-42-1); Reeve, 1865, Conch. Icon., 15, *Cerithium*: sp. 35, pl. 6, figs. 35, a, b, c; Tryon, 1887, Man. Conch., 9: 129, pl. 61, figs. 71, 72; Lamarck, 1822, Anim. sans Vert., 7: 76; M. Smith, 1937, East Coast Marine Shells, p. 106, pl. 38, fig. 13; Morris, 1951, A Field Guide to the Shells, p. 159, pl. 32, fig. 1 (is *C. lutosum* Menke); Abbott, 1954, American Seashells, p. 154, pl. 19,q; Perry and Schwenkel, 1955, Marine Shells of the Western Coast of Florida, pp. 141-142, pl. 27, fig. 193; Warmke and Abbott, 1961, Caribbean Seashells, p. 73, pl. 13,n; Weisbord, 1962, Bull. Amer. Paleont., 42(193): 172, pl. 15, figs. 3, 4; Abbott, 1968, Seashells of North America, pp. 88, 89, fig. 8.

Cerithium eburneum Bruguère. Kiener, 1841, Coquilles Vivantes, 5, *Cerithium*: 44, pl. 10, fig. 2.

Cerithium algicola C. B. Adams 1848. Proc. Boston Soc. Nat. Hist., 2: 5, no fig. (Jamaica; lectotype MCZ 186026, selected by Clench and Turner, 1950. Occ. Papers Moll., 1 (15): 255, pl. 37, fig. 4); Reeve, 1865, Conch. Icon., 15, *Cerithium*: sp. 63, pl. 10, fig. 63; Dall, 1892, Trans. Wagner Free Inst. Sci. Phila., 3(2): 282; M. Smith, 1937, East Coast Marine Shells, p. 105, pl. 38, fig. 10 (is *C. atratum* Born); Abbott, 1954, American Seashells, p. 154, pl. 19,p; Abbott, 1958, Acad. Nat. Sci. Phila., Mongr. 11, p. 40; Coomans, 1958, Stud. Fauna Curaçao, 8(31): 69, pl. 11 (the specimen illustrated is *C. atratum*); Warmke and Abbott, 1961, Caribbean Seashells, p. 73, pl. 13,n; Rice and Kornicker, 1962, Pub. Inst. Mar. Sci. Texas, 8: 371, pl. 3, fig. 10; Abbott, 1968, Seashells of North America, pp. 88, 89, fig. 10.

Cerithium pulicarium Philippi 1848. Zeitschr. f. Malak., 20: 20, no fig. (Yucatan; type not located); Philippi, 1849, Abbild. Beschreib. Conch., 3(4): 18, pl. 1, fig. 4).

Cerithium planispiratum Sowerby 1855. Thes. Conch., 2: 857, pl. 180, fig. 91 (no type-locality; holotype, BM(NH) 1907-10-28-214).

Cerithium fenestratum Sowerby 1855. Thes. Conch., 2: 860, pl. 180, fig. 100 (no type-locality; type not found).

Cerithium novaehiberniae A. Adams 1855, [In] Sowerby, Thes. Conch., 2: 857, pl. 180, figs. 84, 85 (Florida; holotype, BM(NH) 1907-10-28-156).

Cerithium lymani Pilsbry 1949. Nautilus, 63(2): 66,

pl. 1, fig. 12 (off Hudson, Florida; holotype ANSP 185475).

Cerithium variabile C. B. Adams. Rice and Kornicker, 1962, Pub. Inst. Mar. Sci. Texas, 8: 377, pl. 4, fig. 3, non C. B. Adams.

Cerithium eburneum C. B. Adams. Rice and Kornicker, 1962, Publ. Inst. Mar. Sci. Texas, 8: 371, pl. 4, fig. 20 (C. B. Adams given as author in error for Bruguère).

Description. Shell reaching 43 mm in length, solid, stubby to elongate, structure and sculpture variable within and between populations throughout range. Whorls 9-12; protoconch often missing or eroded. Sculpture normally of 4-6 spiral rows of small rounded beads or tubercles, variable in number; beads slightly larger in the middle row; other spiral rows and associated beads reduced or entirely lacking in some specimens with only the middle row remaining. In such cases beads on middle spiral row may be large, pointed and axially drawn out to form low ribs; there may be two nodulose cords on the last whorl above the concavity of the base. In all forms there is an over-all sculpture of fine spiral threads. Large former varices are often present but may be entirely lacking in some specimens. Varix thick, frequently present opposite the aperture. Some heavy-shelled forms are stubby, laterally compressed, with smooth, polished appearance. Sutures slightly impressed. Aperture oval with a short, reflexed siphonal canal. Anal canal short, a distinct anal sulcus extending well within the aperture. Outer lip crenulate, usually thin. Color variable, usually white flecked with spots or blotches of varying shades of brown; heavy-shelled forms frequently with distinct brown band at lower portion of each whorl. Operculum brown, corneous, ovate and paucispiral with a well-defined eccentric nucleus. Periostracum not evident. Radula 2-1-1-1-2. Animal color variable within and between populations; color limited to upper portions of foot, head and snout; mantle beneath shell usually bright yellow. Gonadal ducts open; no anterior receptaculum seen. Reproduction oviparous; egg mass filamentous, each capsule containing a single ovum; planktotrophic veliger stage.

length	width	no. whorls	
43 mm	13 mm	13	Bimini, Bahamas
34	13	11+	Davis Harbor, Eleuthera, Bahamas
27	11	10	Ensenada de Mayo, Matanzas, Cuba
26	10	9	Swan Islands
23	12	10+	Carrie Bow Cay, British Honduras
20	8	10	St. Thomas, Virgin Islands
19	8	9	Turkey Point, Dade Co., Florida

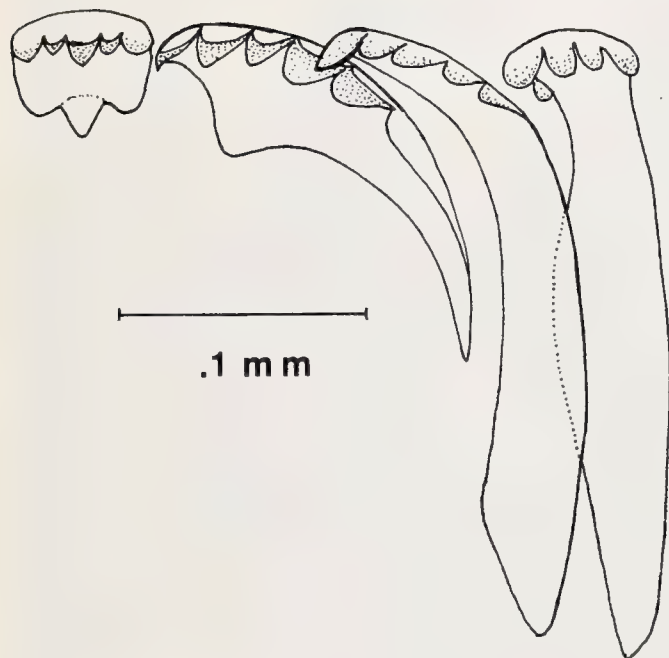


Plate 30. *Cerithium eburneum* Bruguière, from Bear Cut, Key Biscayne, Florida. Radula, half-row.

Remarks. Four to five beaded spiral cords and in particular the nodular to spinose peripheral cord are the distinguishing characters of this species. *Cerithium eburneum* occurs subtidally, just below the low tide mark usually in habitats associated with *Thalassia* communities, where it feeds on epiphytic algae and detritus. This species is often found with *C. muscarum* and occasionally with *C. litteratum*. A population studied in Florida (Houbrick, 1974, b, c) had its reproductive season from January through March. Egg masses appeared throughout this time and veligers hatched from egg capsules in 3-4 days. Eggs and larvae are similar to those of *C. atratum* and *C. litteratum*.

Young snails appeared in the population in mid-summer and were seen as late as November. Adult size was reached in 3 months and

I estimated that the life span was about one year.

Cerithium eburneum shows considerable variation in shell sculpture, as demonstrated by the extensive synonymy. Some morphs, particularly of immature specimens, are confused with *C. atratum* or *C. muscarum*. Dall (1892) noted that *C. algicola* (= *C. eburneum*) was frequently "sent out under the name of *atratum*."

Some morphs of *C. eburneum* are heavily-shelled and polished. These are found in coral reef habitats (Pl. 31, figs. 3, 4, 5, 9). The same phenomenon has been noted in *C. litteratum* and specimens of this kind have been given the varietal name of "semiferrugineum" by various authors. These morphs are not geographically isolated but appear to be ecophenotypes.

Bruguière's (1792) original description of *C. eburneum* is somewhat inadequate and was not accompanied with a figure. Kiener (1841) illustrated the species and his figures serve to give us an idea of Bruguière's species. Lamarck (1799) repeated Bruguière's description and mentioned that he did not know of any figure of the species. In Lamarck's (1810) "Système Animaux sans Vertèbres," he mentioned "mon cabinet" in conjunction with this species. Both Lamarck and Bruguière worked together and it is possible that the specimens described by Bruguière passed into that portion of Lamarck's collection referred to as "mon cabinet," and are now in the Muséum d'Histoire Naturelle at Geneva. The largest specimen of *C. eburneum* agrees with Lamarck's measurement (24 mm), is from "the Antilles," corresponds closely with what we understand as *C. eburneum*, and may be part of the type-lot of Bruguière. This specimen, Geneva Museum 1097-42-1, is here designated the lectotype of *C. eburneum* (Pl. 31, fig. 6).

Difficulties are encountered when one attempts to separate specimens of *C. eburneum* from those of *C. algicola* C. B. Adams, 1848. Sowerby (1855) was the first to indicate

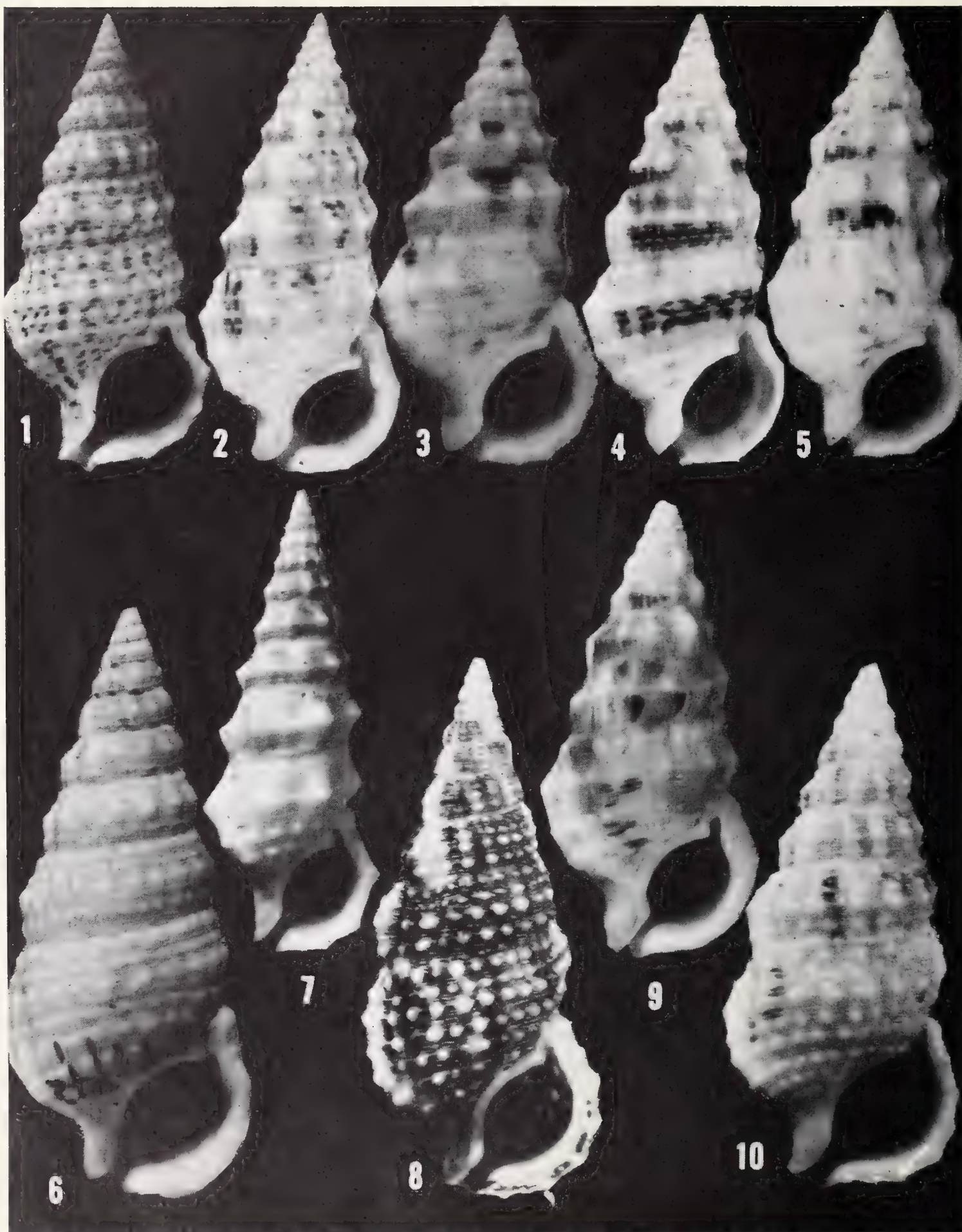


Plate 31. *Cerithium eburneum* Bruguière, showing variation in shell color and form. Fig. 1. St. Petersburg, Florida (25 mm); Fig. 2. Davis Harbor, Eleuthera, Bahamas (29.1 mm); Fig. 3. St. Thomas, Virgin Islands (19 mm); Fig. 4. Tokas Cay, Bimini, Bahamas (26 mm); Fig. 5. St. Thomas, Virgin Islands (18.4 mm); Fig. 6. Lectotype, Geneva Museum 1097-42-1, Guadeloupe (24

mm); Fig. 7. *Cerithium lymani* Pilsbry, paratype ANSP 185475, off Hudson, Pasco Co., Florida (21.2 mm); Fig. 8. Bear Cut, Key Biscayne, Miami, Florida (22 mm) [melanistic form]; Fig. 9. Tokas Cay, Bimini, Bahamas (26 mm); Fig. 10. Bear Cut, Key Biscayne, Miami, Florida (22.8 mm).

that *C. algicola* was a synonym of *C. eburneum*. Reeve (1865) agreed and commented upon the wide color variations found in the latter. Abbott (1958) and Warmke and Abbott (1961) have suggested that *C. algicola* may be a genetic race or form of *C. eburneum*. Abbott (1958) noted the existence of intergrades between the two species in collections from Grand Cayman Island. I have seen populations exhibiting similar inter-

The type of Philippi's *C. pulicarium* has not been found, but his illustration of this species (1849, pl. i, fig. 4) corresponds closely with *C. eburneum*, and Tryon (1887) cited *pulicarium* as a synonym of *eburneum*.

Tryon (1887) listed *C. planispiratum* Sowerby, 1855, and *C. fenestratum* Sowerby 1855, as synonyms of *C. eburneum*. I have examined the holotype of *C. planispiratum* and am in agreement with Tryon. The type-

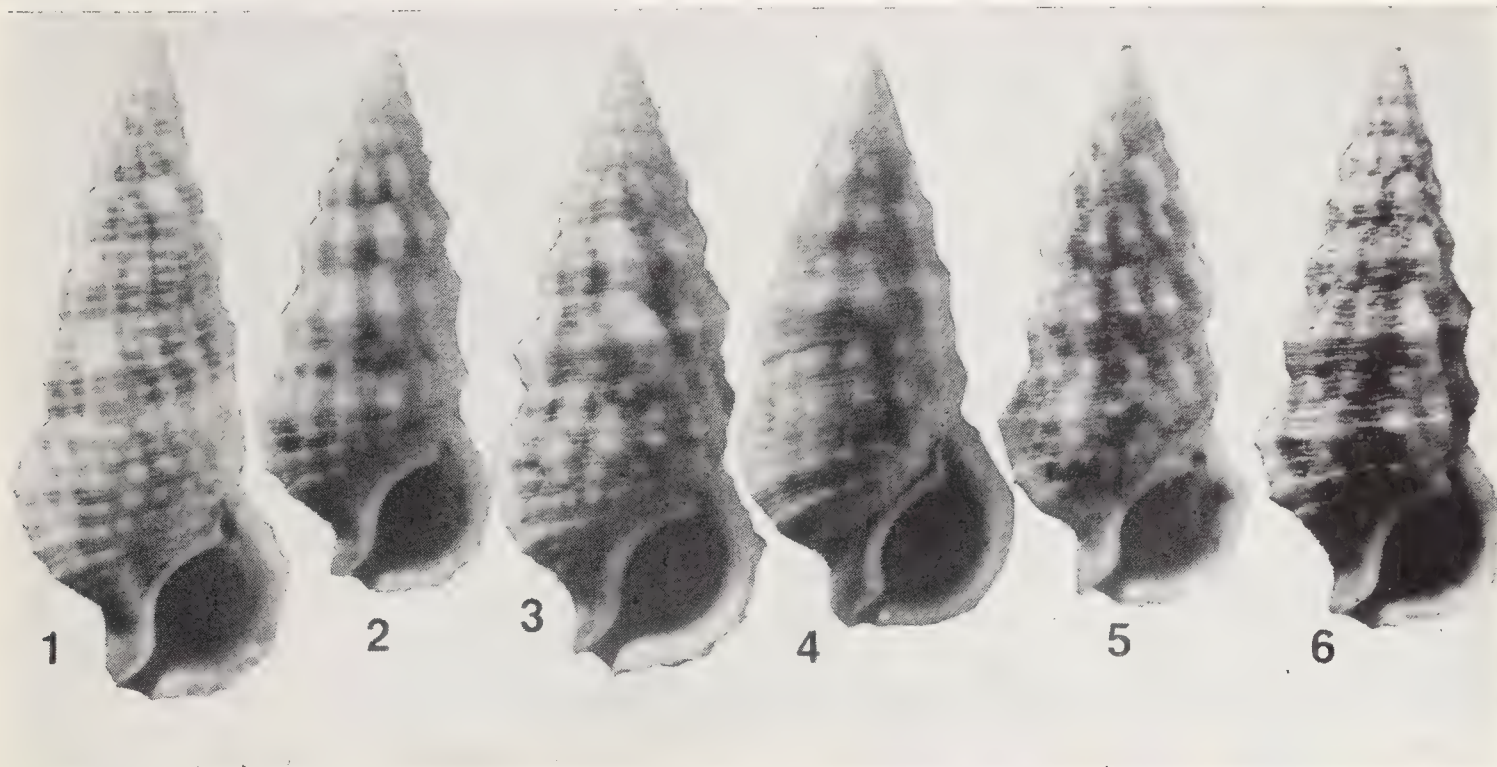


Plate 32. Paratypes of *Cerithium algicola* C. B. Adams (= *C. eburneum*), showing, from left to right, gradations from typical *C. eburneum* morphs into "algicola"-like

morphs. The shell to the far right is the lectotype of *C. algicola*, MCZ 186026, selected by Clench and Turner (1950).

gradations from the Florida Keys, the Bahamas, and various places throughout the Antilles. Examination of the paratypes of C. B. Adams from Jamaica reveals the same phenomenon of intergradation (Pl. 32, figs. 1-6). Some of these specimens closely correspond with the aforementioned material of Lamarck, and others, conform closely with the lectotype of *C. algicola* (Pl. 32, fig. 6) selected and figured by Clench and Turner (1950). It is clear, from the evidence of the type-material, from examination of living populations of *C. eburneum*, and from extensive examination of museum collections, that *C. algicola* is a synonym of *C. eburneum*.

material of *C. fenestratum* is missing but on the basis of the descriptions and figures in Sowerby (1855) and Reeve (1865), I am inclined to follow Tryon's judgement. I have also seen the holotype of *C. novaehiberniae* A. Adams 1855 and believe it too is a synonym of *C. eburneum*.

Pilsbry (1949) described *C. lymani* from off Hudson, Florida, on the Gulf of Mexico (Pl. 31, fig. 7) and commented upon its resemblance to *C. muscarum*. Although some specimens of his type-lot have the markings of *C. muscarum*, they differ in form and sculpture from that species. Having seen similar material from Hudson, Crystal

Beach, Clearwater, Anclote Key, South Lake Worth, all in Florida, and Old Providence Island, Bahamas, I believe that *C. lymani* is merely a genetic morph or ecophenotype of *C. eburneum*, with strong resemblance to the "albicola" form. A series of *C. eburneum* from Caesar's Creek, Florida has intergrades ranging from typical *C. eburneum* morphs to the "lymani" forms.

Recent descriptions and figures of this species occur under the names *eburneum* and *albicola*. Morris' (1951) illustration of *C. eburneum* is *C. lutosum* Menke. Cooman's (1958) figure of *C. albicola* is *C. atratum* (Born).

Fossil record. *Cerithium eburneum* has been reported from the Pliocene of Venezuela by Weisbord (1962) and from the Pleistocene of Barbados by Gregory (1895). Weisbord noted a similarity of his fossils to *C. costaricensis* Olsson, 1922, from the Pliocene of Costa Rica, and to *C. harrisi* Maury, 1912 and *C. isabellae* Maury, 1912, from the Miocene of Trinidad. Dall (1892) recorded it, under the name *albicola*, from the Shell Creek and Caloosahatchee beds of Florida and the Pliocene of Costa Rica. Woodring (1928) recorded it, under the name *albicola*, from the Miocene of Bowden, Jamaica. *C. eburneum* has also been listed (as *albicola*) by McGinty (1970) from the "Glades" Unit of Southern Florida.

Range. Bermuda, the Bahamas and Florida from New Smyrna Beach, Florida south to the Florida Keys and on the west coast north to Crystal River. The Gulf coast of Mexico from Vera Cruz to Yucatan, throughout the Caribbean from Central America to the Lesser Antilles and south to N.E. Brazil. Depth range to 10 m.

Specimens examined. FLORIDA: New Smyrna Beach (LACM); Palm Beach; Lake Worth Inlet; Virginia Key, Miami; Turkey Point, Biscayne Bay (all UMML); Boca Raton (DMNH); Ft. Lauderdale; S.W. Point, Key Biscayne; 79th St. Causeway, Miami; South side of Key Largo; Grayhound Key; Little Conch Key; Pigeon Key; Key West (all AMNH); Cape Sable (ANSP); Dry Tortugas (UMML); Loggerhead Key, Dry Tortugas; Bottlepoint Key, Florida Bay (both USNM); Sarasota

(MCZ); Pine Island; Sanibel; Bradenton Beach (all AMNH); Charlotte Harbor (USNM); Pass-a-Grille (MCZ); Boca Ciega Bay (USNM); Madeira Beach (UMML); St. Petersburg (AMNH); Garden Cove, Largo (ANSP); Tampa Bay (USNM); Gulfport (LACM); Crystal River, St. Joseph Sound (USNM); N. Anclote Channel, Anclote Key; Ozone; Crystal Beach (all AMNH); off Hudson (USNM). MEXICO: Vera Cruz; Ciudad Carmen, Campeche (both MCZ); Progreso, Yucatán; Isla Cancun, Quintana Roo; Silam (all ANSP); Alacran Reef, Yucatán (Rice and Kornicker, 1962); Cozumel Island; Mujeres Island; Espíritu Santo

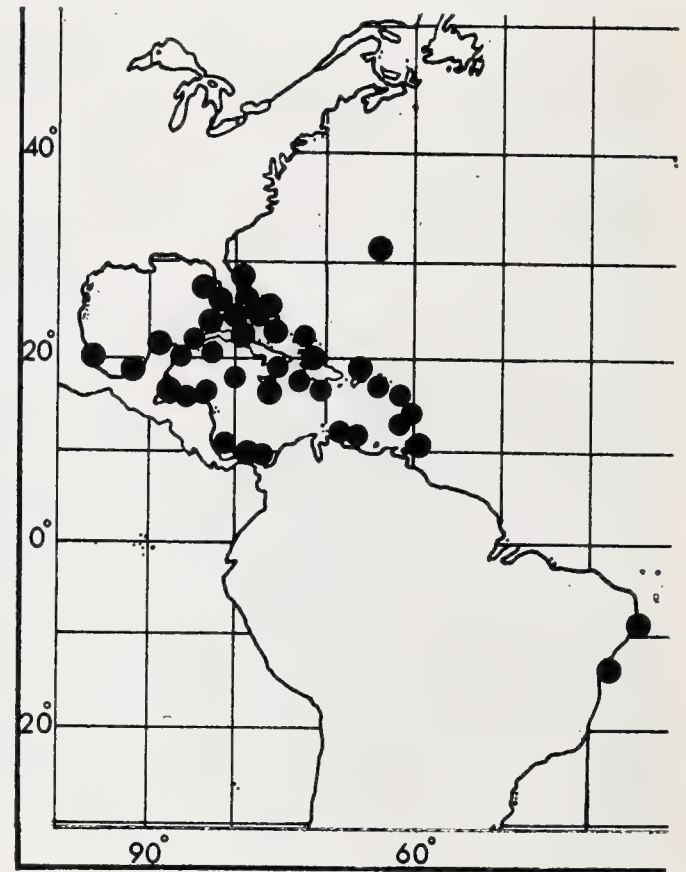


Plate 33. Geographical distribution of *Cerithium eburneum* Bruguière.

Bay, Quintana Roo; Rio Lagartos, Yucatán (all USNM). BRITISH HONDURAS: Carrie Bow Cay (USNM). HONDURAS: Roatan Island (USNM). PANAMA: Ft. Randolph (MCZ); Coco Solo (LACM); Toro Point (USNM); Colón; N.E. end of Payardi Island (both USNM). BERMUDA: (MCZ and ANSP). BAHAMAS: Great Guana Cay, Abaco Island (AMNH); North Bimini (USNM); Tokes Cay, Bimini (UMML); Lyford Cay, New Providence (AMNH); South Beach, New Providence (MCZ); Mintie Bar, SE end S Bight, Andros Island (USNM); Harbour Island, NE Eleuthera (AMNH); Highborne Cay, Exuma (USNM); Spanish Wells, Eleuthera (AMNH); Cat Island (MCZ); Dunmore Town, Harbour Island (AMNH); San Salvador (USNM); Galliot Cay, NW end Cape Santa Maria, Long Island (AMNH); Double Headed Shot Cay, Sal Cay (USNM); Bell Cay, E Caicos (USNM). CUBA: Punta Colorado, Pinar del Rio; Cabo Cajon, Pinar del Rio; Santa Lucia, Pinar del Rio; Cabañas Harbor, Pinar del Rio (all USNM); Rosario, Havana (UMML); Carbeneras, Mantanzas; Camarioca,

Matanzas (both AMNH); Ensenada de Maya, Matanzas; Varadero Beach, Matanzas (both USNM); Cárdenas Bay, Matanzas (COP); Bubas Cay, Cárdenas, Matanzas; Cuesco Beach, Oriente; Guantánamo Bay, Oriente; Esperanza, Las Villas; Siguanea Bay, Isle of Pines (all USNM). HAITI: Tarbeck, Dept. de Sud; Little Reef, Petit Goâve (all USNM). DOMINICAN REPUBLIC: Piedra Prieta Reef, Baharona (AMNH); Puerto Sosua (MCZ); Monti Cristi (ANSP); Beata Island (USNM). PUERTO RICO: San Juan (UMML); Gata Island; Guánica Harbor; Salinas Cove (all AMNH); Fayardo; Playa de Humacao, E. coast Puerto Rico (both USNM); Mayagüez (UMML). JAMAICA: Port Royal; Kingston (both AMNH); Little River (USNM). LESSER ANTILLES: Mary's Creek, St. Johns (UMML); Cruz Bay, St. Johns; Christiansted Lagoon, St. Croix (both COP); Black's Point, Falmouth Bay, Antigua; Barbuda; St. Thomas; Pigeon Island, St. Lucia; Sandy Island, Anguilla; Pelican Island, Barbados; Buccoo Reef, Tobago (all USNM). CARIBBEAN ISLANDS: Grand Cayman Island; W. end of Caymen Brac (both AMNH); Aruba, Curaçao (both COP); Ironwood Point, Old Providence Island (AMNH); San Andres Island (ANSP); Cayos de Albuquerque (UMML); Swan Island (USNM). BRAZIL: Pernambuco (MCZ); Stapoa, Bahia (AMNH).

Cerithium (*Theridium*) *guinaicum* *Philippi*

Plates 34-37

Murex pictus Wood 1828. Index. Testaceo. (Supplement), p. 15, pl. 5, *Murex*, fig. 24 (no type-locality); non Basterot, 1825.

Cerithium mitriforme Wood 1828. Index. Testaceo. (Supplement), p. 34, pl. 5, *Murex*, fig. 24; [non *Murex mitriformis* Wood, p. 15, no. 25].

Cerithium pictum Wood. Kiener, 1841, Coquilles Vivantes, 5, *Cerithium*: 38, pl. 12, fig. 2; G. P. Deshayes [in] Lamarck, 1843, Anim. sans Vert., ed. 2, 9: 310.

Cerithium guinaicum Philippi 1849. Abbild. Beschreib. Conch., 3(4): 17, pl. 1, fig. 13 (Gabon in Guinea; types not found; fig. 13 here designated to represent the lectotype); Sowerby, 1855. Thes. Conch., 2: 866, pl. 181, figs. 126, 127; Reeve, 1865. Conch. Icon., 15, *Cerithium*: sp. 51, pl. 8, fig. 51; Tryon, 1887. Man. Conch., 9: 127, pl. 22, figs. 55, 56; Kobelt, 1898, Conch. Cab., 1, *Cerithium* (26): 81-82, pl. 16, figs. 1, 2; Dautzenberg, 1912. An. Inst. Oceanogr. Monaco, 5(3): 41; Nicklès, 1950. Manuels Ouest-Africains, 10: 63, fig. 75.

Cerithium moenensis Gabb 1881. J. Acad. Sci. Nat. Phila., Ser. 2, 8(4): 360-361, pl. 46, fig. 49 (Moen, Costa Rica; holotype, ANSP 3400, paratypes USNM 21054).

Cerithium stantoni Dall 1907. Nautilus, 21: 22-23 (no figure; complex description based on a specimen from St. George Cay, Belize, British Honduras and one from the Florida Keys; types, USNM 110469, 150294; (USNM 110469 here designated as holotype).

Cerithium auricoma Schwengel 1940. Nautilus, 53(4): 109, pl. 12, figs. 8, 8a (Washerwoman Key, Pelican Shoals, near Key West, Florida; holotype, ANSP 175133;

paratypes USNM); Warmke and Abbott, 1961. Caribbean Seashells, p. 73, pl. 13, fig. 9.

Theridium moenensis moenensis Gabb. Rehder 1940. Nautilus, 54(2): 72-73.

Theridium moenensis stantoni Dall. Rehder 1940. Nautilus 54(2): 72-73.

Theridium moenensis auricoma Schwengel. Rehder 1940. Nautilus 54(2): 72-73.

Cerithium caribbaeum M. Smith 1946. Nautilus, 60(2): 60-61, pl. 6, fig. 4 (dredged off Manzanillo Island, Colón, Canal Zone; holotype, Beal Maltby Museum, Rollins College, Winter Park, Florida).

Description. Shell solid, robust, broadly conic, reaching 45 mm in length. Width almost $\frac{1}{2}$ of height, 9-12 whorls in adults, early whorls usually eroded, last 4 normally with 7-9 broad, rounded axial ribs extending from suture to suture and with equal interspaces. Suture prominent, undulating. Ribs obsolete at periphery of body whorl. Varix on body whorl opposite outer lip. Sculpture of fine white spiral threads, their interspaces usually darker in color and with 2-3 finer microscopic spiral threads. Aperture obliquely ovate, constricted both above and below; columellar pillar strong. Siphonal canal narrow, of medium length and sharply reflexed. Anal canal with a distinct sinus, forming a prominent groove extending well within the shell. Outer lip thick, slightly crenulate. Color bright, variable, ranging from cream to yellow-brown and orange; lower portion of each whorl usually of a solid, darker color, but may be marbled. Operculum corneous, ovate, paucispiral and with a well-defined ec-

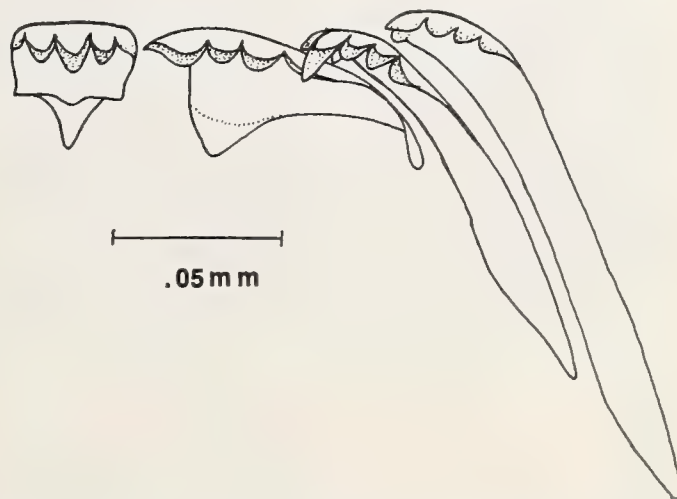


Plate 34. *Cerithium guinaicum* Philippi from Sand Key, off Key West, Florida. Radula, half-row.

centric nucleus. Periostracum not noticeable, even in fresh specimens. Radula 2-1-1-1-2. Base color of animal cream with small brown and white spots; brown color limited to folds and wrinkles on tentacles, upper portion of snout and foot; edge of mantle with green-blue sensory papillae; mantle beneath shell bright orange. Gonoducts open; no anterior receptaculum seminis. Reproduction oviparous; egg mass filamentous; each capsule containing a single ovum; development in egg capsule to veliger stage (D'Asaro 1969).

length	width	no. whorls	
45 mm	12 mm	11	Sand Key, Florida
36	10	11	São Thome, Gulf of Guinea
35	11	11	Carrie Bow Cay, British Honduras
31	15	9	Manzanillo Id., Colón, Canal Zone
30	11	10	Carrie Bow Cay, British Honduras
29	11	10	Baie de Libreville, Gabon
24	10	10	Sand Key, Florida

Remarks. *Cerithium guinaicum* is one of the largest and least known of the Atlantic *Cerithium* species. Broad axial ribs crossed by fine spiral striae are its distinguishing characters. This species is also the most colorful *Cerithium*. Fresh specimens are usually brightly colored with bands of varying shades of brown, yellow and cream. It is a subtidal, reef-dwelling species and does not vary in its vertical distribution in the benthos as do other *Cerithium* species. I have found it in the Florida Keys and in British Honduras where it commonly burrows in the carbonate-sand areas associated with the rubble zones of reef flats. It is an algal-detritus feeder. D'Asaro (1969) described and illustrated the egg capsules and noted that *guinaicum* spawned in July and had a free-swimming veliger stage.

Wood (1828) first figured this species under the name *Murex pictus* (on — p. 15, *Murex* no. 24, of the *Supplement* of the *Index Testaceologicus*), but made an error

in referring to it again on p. 34 as *Cerithium mitriforme* in reference to pl. 15, confusing fig. 25, a *Mitra*, with fig. 24 which he previously indicated was *Murex pictus*. His excellent figure of this species closely resembles brightly colored, fresh specimens I have examined from west Africa, British Honduras and the Florida Keys. Wood's name however, is a junior homonym of a fossil species, *Cerithium pictum* Basterot, 1825. Wood gave no locality for his species but Deshayes (1843) mentioned having similar specimens from Senegal. Kiener (1841) erroneously assigned Wood's species to the Indian Ocean.

Philippi (1849) described this species as *Cerithium guinaicum*, based on a specimen from "Gabon in Guinea." The type material has not been located. Philippi's illustration of his species is adequate, but a more recent illustration and figure appears in Nicklès (1950, p. 63, fig. 72) and is clearly the same species as Wood's *Cerithium pictum*. Philippi's fig. 13 is here considered representative of the lectotype.

The species has also been described from the Pliocene of Moen Hill, near Puerto Limón, Costa Rica, by Gabb (1881) under the name *Cerithium moenensis*. Gabb's type material, as he himself noted, corresponds closely with *C. guinaicum* from West Africa and I have been unable to separate Recent material from Gabb's types and fossils I have examined from the Moen formation of Costa Rica.

Dall (1907) named *Cerithium stantoni* using a composite description based on a specimen from Belize, British Honduras (USNM 150294) and one from the Florida Keys (USNM 110469). Measurements were based on the Florida specimen while the color notes were taken from the Belize specimen. Dall noted a similarity between his new species and Philippi's *C. guinaicum*. Having examined Dall's type material it is evident that his *C. stantoni* is a synonym of *C. guinaicum*. I here designate USNM 110469 as the holotype of *C. stantoni*.

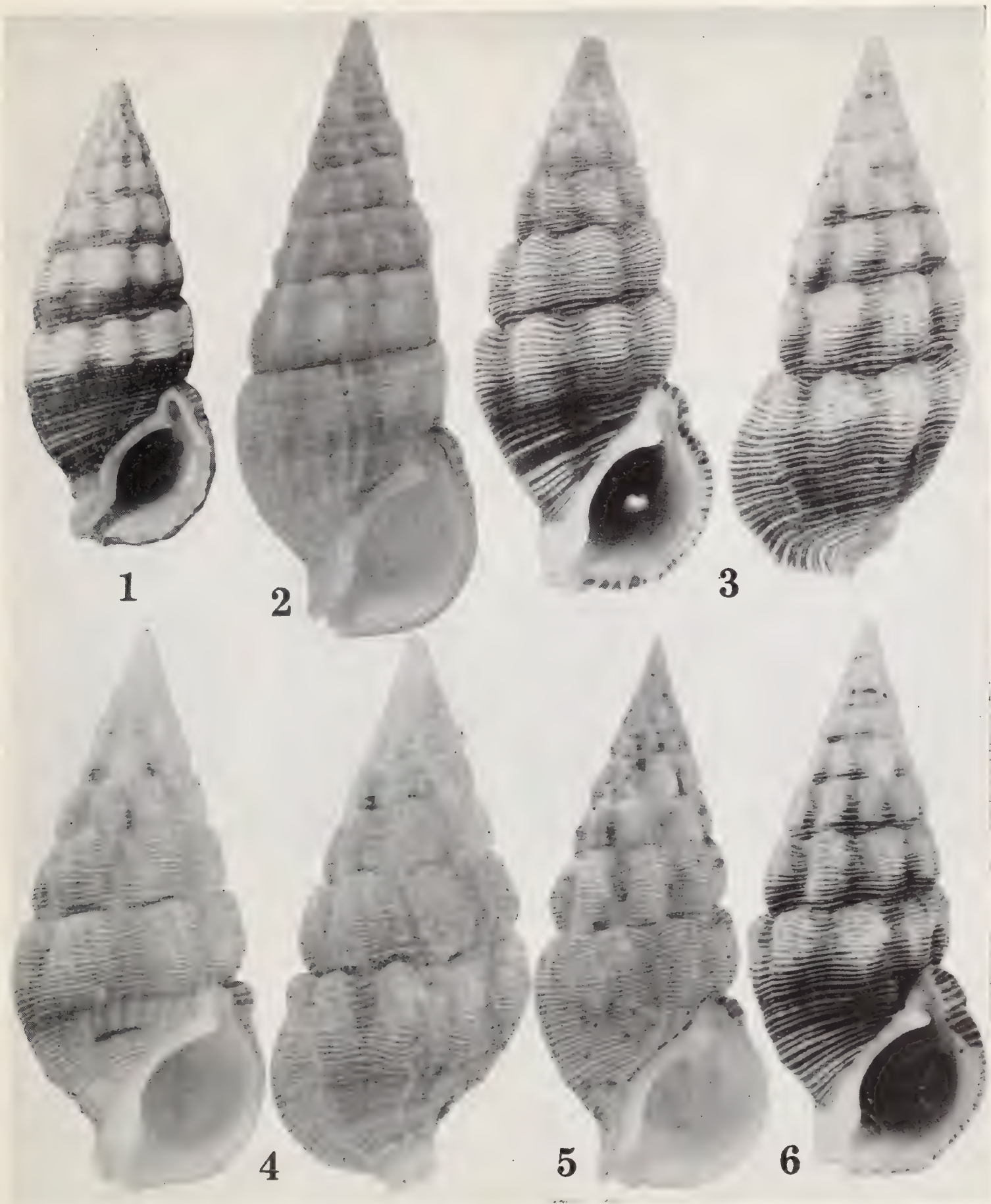


Plate 35. *Cerithium guinaicum* Philippi. Fig. 1. Man of War Bay, Freetown, Sierra Leone (36 mm); Fig. 2. Baie de Libreville, Gabon (35.2 mm); Figs. 3-6. Long Cay, Glover's Reef, British Honduras (40 mm, 40.4 mm and 41 mm).

Schwengel (1940) described a new *Cerithium* from off Key West as *Cerithium auricoma*. Schwengel's name, *C. auricoma*, is the name best known by recent workers, but is here considered a synonym. Rehder (1940) considered *C. stantoni* and *C. auricoma* as subspecies of *C. moenensis*. Examination of material now available in museums as well as several living populations indicates considerable intraspecific variation. Consequently, I regard *stantoni* and *auricoma* as synonyms of *guinaicum*.

possible that this is due to hybridization between the two species.

Specimens from west Africa tend to be more slender with the spiral threads on their whorls not as well-defined as those from the Caribbean (Pl. 35, figs. 1, 2). West African material is not common in museums and because of the lack of adequate comparative material I am reluctant to assign the west African and Caribbean populations to subspecific rank.

Recent references to *C. guinaicum* appear

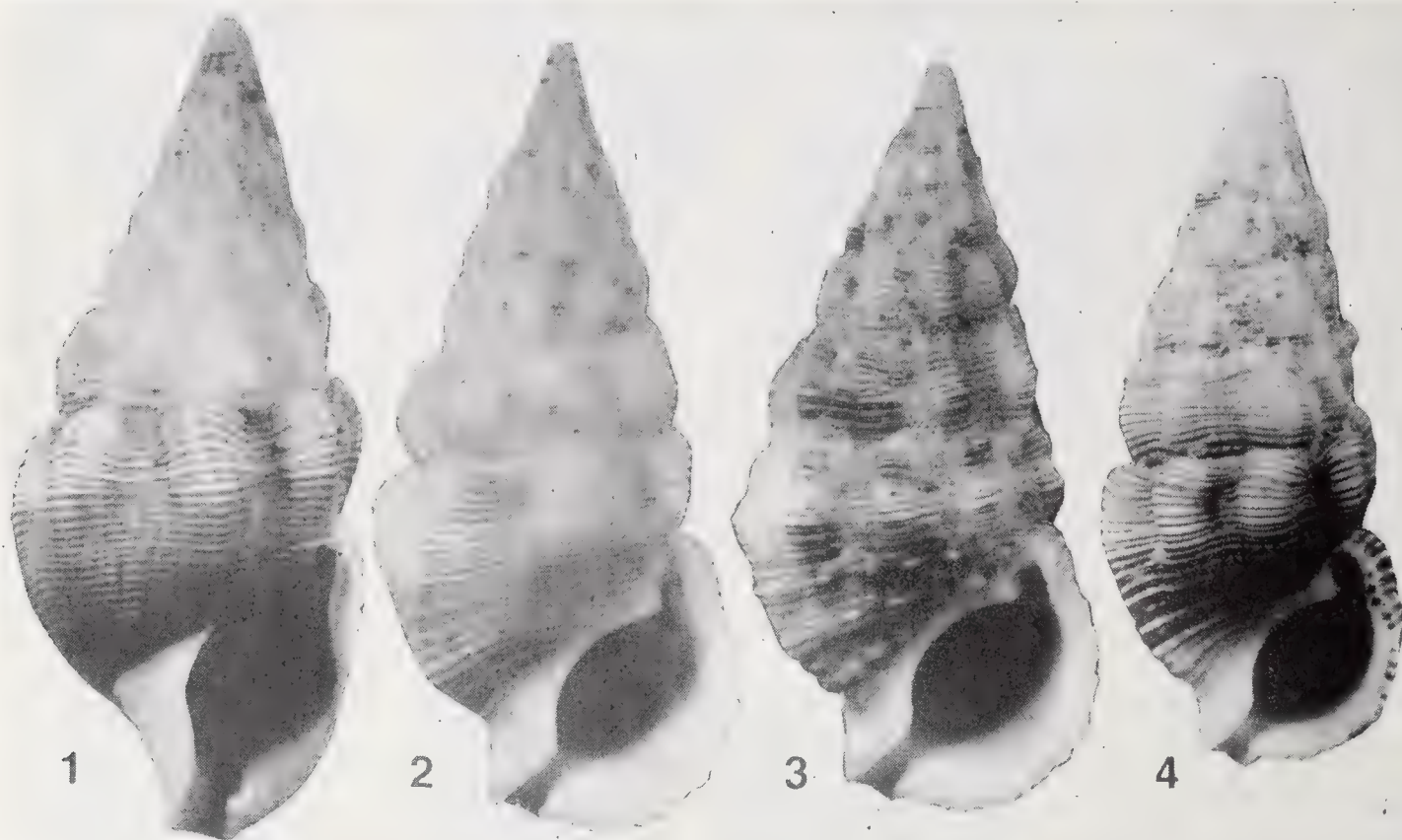


Plate 36. *Cerithium guinaicum* Philippi. Figs. 1-4, Sand Key, off Key West, Florida (34.3 mm, 34 mm, 29 mm and 32.1 mm).

In 1946 M. Smith described a new species, *Cerithium caribbaeum*, based upon material dredged off Manzanillo Island, Colón, Canal Zone. I have not seen the holotype, but both his description and figure clearly indicate that his species is *C. guinaicum*.

In some populations (Sand Key and Ft. Lauderdale, Florida; Carrie Bow Cay, British Honduras) there are intergrades (Pl. 36, figs. 1-4) ranging from typical *C. guinaicum* to forms quite similar to *C. atratum*. It is

under the name *C. auricoma*.

Fossil record. *Cerithium guinaicum* has a geological range from the Pliocene of Costa Rica to the Recent. It has recently been found in the Pleistocene "Glades" unit of southern Florida (Unit "A" of Olsson, Belle Glade Rock Pit; TU locality 201; Hoerle, in litt.). Sub-Recent specimens taken one mile off Pompano, Florida from 20 feet beneath the ocean floor have been identified by Thomas McGinty (Hoerle, in litt.). Dall

(1907) first recorded the species in the Recent fauna of the Caribbean. I do not agree with Pilsbry (1921) that *C. turriculum* Gabb 1873 is an ancestral form of *C. moenensis* [= *guinaicum*].

Range. Eastern Atlantic: from Senegal south to Gabon and among the islands of the Gulf of Guinea. Western Atlantic: South Florida to the Caribbean Islands, and from British Honduras south to Venezuela. Depth range: to 20 m.



Plate 37. Geographical distribution of *Cerithium guinaicum* Philippi.

Specimens examined. WESTERN ATLANTIC: FLORIDA: Palm Beach (USNM); Ft. Lauderdale (AMNH); Margot Fish Shoals, Dade County (USNM); Pelican Shoals, Washerwoman Key, NE of Key West (ANSP); Sand Key, off Key West (USNM). BRITISH HONDURAS: Tarpon Cay; Tobacco Cay; Triangles, 17°19'N; 88°09'N (all ANSP); Carie Bow Cay; Long Cay, Glover's Reef (both USNM). COSTA RICA: Portete, Limón Province (USNM). PANAMA: Colón (USNM). CUBA: Bahía Honda, Pinar del Río; Cárdenas Bay, Matanzas (both USNM); Guantánamo Bay, Oriente (ANSP); Cienfuegos Harbor, Las Villas; Hijo de los Morlas (both USNM). DOMINICAN REPUBLIC: Fort Liberte (USNM). PUERTO RICO: North coast (USNM); Roosevelt Roads (ANSP). LESSER ANTILLES: St. John's Bay, St. Thomas (COP). VENEZUELA: Puerto Cabello (USNM). EASTERN ATLANTIC: SENEGAL: Cape Verde (Dautzenberg, 1912). RIO MUNI: Adje, 20 mi. S. of Benito (MCZ). GABON: Baie de Libreville (USNM); São Thomé Island (Tomlin and Shackleford, 1914); "coast of Guinea" (USNM).

Cerithium (*Theridium*) *lutosum* Menke

Plates 38-43

Cerithium lutosum Menke 1828. Synop. Moll., p. 86 (Havana, Cuba; types not found; neotype USNM 420395, Havana, Cuba, here selected); Menke, 1830, *Ibid.* p. 58; Sowerby, 1855. Thes. Conch., 2: 868, pl. 182, figs. 146-148; Smith, M., 1937. East Coast Marine Shells, p. 106, pl. 38, fig. 24; Reeve, 1865. Conch. Icon., 15, *Cerithium*: sp. 113, pl. 16, fig. 113.

Cerithium ferrugineum Say 1832. Amer. Conch., no. 5, pl. 49, fig. 3. (South Carolina; holotype, ANSP 17777), non Bruguière, 1792 nec Menke, 1830; Reeve, 1865. Conch. Icon., 15, *Cerithium*: sp. 92, pl. 14, fig. 92.

Cerithium sagrae Orbigny 1842, Mollusques. [In] Sagra, Hist. L'île Cuba, 2: 156-157, pl. 23, figs. 17-19. (Cuba; lectotype BM(NH) 1854-10-4-392, [9.9 mm in length], here selected).

Cerithium variabile C. B. Adams 1845. Proc. Boston Soc. Nat. Hist., 2: 5, no fig. (Jamaica; lectotype, MCZ 186056, selected by Clench and Turner, 1950. Occ. Papers Moll., 1(15): 354, pl. 37, fig. 2), non Deshayes, 1833; Reeve, 1865. Conch. Icon., 15, *Cerithium*: sp. 91, pl. 13, fig. 91; Abbott, 1954. American Seashells, pp. 154-155, pl. 19,0; Perry and Schwengel, 1955. Marine Shells of the Western Coast of Florida, pp. 142-143, pl. 27, fig. 195; Abbott, 1958. Acad. Nat. Sci. Phila., Mongr. 11, p. 39; Warmke and Abbott, 1961. Caribbean Seashells, pp. 72-73, pl. 13,w; Rice and Kornicker, 1962. Pub. Inst. Mar. Sci. Texas, 8: 377, pl. 4, fig. 3 (the specimen illustrated is *C. eburneum*); Coomans, 1958. Stud. Fauna Curaçao, 8(31): 70, pl. 11.

Cerithium mutabile C. B. Adams 1845. Proc. Boston Soc. Nat. Hist., 2: 5, no fig. (Jamaica; lectotype, MCZ 186094, selected by Clench and Turner, 1950. Occ. Papers Moll., 1(15): 313, pl. 37, fig. 9), non Lamarck, 1804.

Cerithium nigrinum Philippi 1848. Zeitschr. f. Malak., 20: 24, no fig. (no type-locality; type not located); Philippi, 1851. Abbild. Beschreib. Conch., 3(4): 18, pl. 1, fig. 19 (Philippi's fig. here selected to represent the holotype).

Cerithium megasoma C. B. Adams 1850. Contrib. Conch., 7: 119-120, no fig. (Jamaica; lectotype, MCZ 186096, selected by Clench and Turner, 1950. Occ. Papers Moll., 1(15): 306, pl. 37, fig. 8).

Cerithium versicolor C. B. Adams 1850. Contrib. Conch., 7: 19, no fig. (Jamaica; lectotype, MCZ 186054, selected by Clench and Turner, 1950. Occ. Papers Moll., 1(15): 355, pl. 37, fig. 1), non Philippi, 1848.

Cerithium lutosum Menke. Sowerby, 1855, Thes. Conch., 2: 868, pl. 182, figs. 146, 147, 148 [error for *lutosum* Menke].

Cerithium sayi "Menke" Sowerby 1855. Thes. Conch., 2: 868, pl. 182, figs. 149, 150, 151 (North America; types not found, fig. 149 selected to represent the lectotype); Sowerby, 1865 [in] Reeve, Conch. Icon., 15, *Cerithium*: sp. 110, pl. 16, fig. 110.

Cerithium rissoidae Sowerby 1865. [in] Reeve, Conch. Icon., 15, *Cerithium*: sp. 107, pl. 15, fig. 107 (St. Thomas, West Indies; holotype BM(NH); Coomans, 1958. Stud.

Fauna Curaçao, 8(31): 70.

Cerithium thomasiae Sowerby 1865. Conch. Icon., 15, *Cerithium*: sp. 108, pl. 15, fig. 108 (St. Thomas, West Indies; syntypes, BM(NH), no reg. no.).

Cerithium bermudae Sowerby 1865. [in] Reeve, Conch. Icon., 15, *Cerithium*: sp. 86, pl. 13, fig. 86 (Bermuda; syntypes, BM(NH), no reg. no.).

Cerithium alabastrum Mörch 1876. Malak. Blätt., 23: 120-121 (St. Thomas; type ? COP).

Theridium biminiense Pilsbry and McGinty 1949. Nautilus, 63(1): 13, pl. 1, figs. 6, 6a, 6b (Turtle Rocks, Bimini Id., Bahamas; type ANSP 185468).

Cerithium variabilis C. B. Adams. [sic] Webb, 1942, United States Mollusca, p. 41, pl. 14, fig. 17.

Batillaria minima rawsoni Mörch 1876. Bequaert, 1942, Johnsonia 1(5): 10, pl. 5, figs. 8-10; non *Batillaria minima* Mörch.

Cerithium (*Theridium*) *variabile* C. B. Adams. Andrews, 1971, Sea Shells of the Texas Coast, p. 79, with figure, non C. B. Adams.

Description. Shell reaching 20 mm. Whorls 8-10, slightly convex; protoconch usually present, white. Sutures distinct. Sculpture on upper whorls of 3-4 spiral rows of even-sized tubercles or beads interspaced with fine spiral striations and threads which may be beaded; body whorl with 7-8 spiral rows of beads above the periphery and with fine spiral beaded threads on the base. Sculpture sometimes almost obsolete, former varices usually present; varix on body whorl opposite aperture. Aperture ovate; callus with fine wash of enamel; siphonal canal short and slightly reflexed upward; anal canal weakly developed, scarcely sinuate. Outer lip smooth, sometimes weakly crenulate or toothed interiorly. Color variable; tan to dark brown, grayish white with chestnut mottlings, or en-

tirely white. Operculum tan, corneous, ovate and paucispiral with well-defined eccentric nucleus. Periostracum not evident. Radula 2-I-I-I-2; cusps on rachidian and laterals vary in number. Animal whitish with brown maculations and lines. Gonadal ducts open; reproduction oviparous; egg mass in filamentous coils, jelly-like with large capsules each containing a moderately telolecithal ovum; crawling young hatch in about two weeks. Larval shell has a lightly pitted surface,

length	width	no. whorls	
19.5 mm	6.4 mm	10	Espirito Santo Bay, Quintana Roo, Mexico
15	5	8	Curaçao
14	5	8	Tampa Bay, Florida
12	4	8+	Cartagena, Colombia
8	5	7+	Little River, Jamaica
7	3	7	Vera Cruz, Mexico
5	2	6+	San Blas Islands, Panama

Remarks. *Cerithium lutosum* is distinguished by its small size, short anal and siphonal canals, stubby shape and its overall smooth, beaded appearance. It is the smallest of the Atlantic ceriths and is exceedingly variable in color and shell width. It occurs in great numbers (up to 15,000 snails/m²) on various substrata in the intertidal zone (Houbrick, 1974b). In terms of its vertical distribution on the shore, this species occupies the highest level of the intertidal zone of all Atlantic *Cerithium* species. *C. lutosum* is euryhaline, occurring in both brackish and high salinity environments. It feeds upon detritus and micro-algae; stomach contents of a Port Everglades, Florida population contained an abundance of *Enteromorpha* and *Chaetomorpha*. Development of *C. lutosum* takes place within the egg capsule. Spawning in Port Everglades extends from late winter throughout the spring. Egg masses are distinctive and are deposited in jelly-like filamentous coils containing large capsules with yolky eggs (Pl. 39). Juvenile snails hatch in about two weeks and grow to adult stages in a few months. Their life span is about one year (Houbrick, 1974b,c).

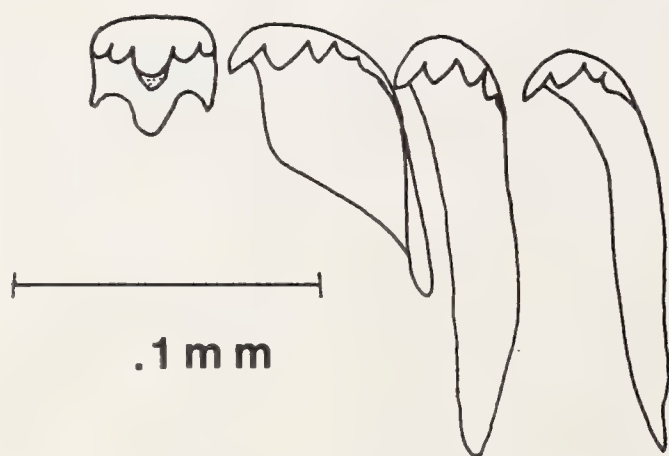


Plate 38. *Cerithium lutosum* Menke from Port Everglades, Florida. Radula, half-row.

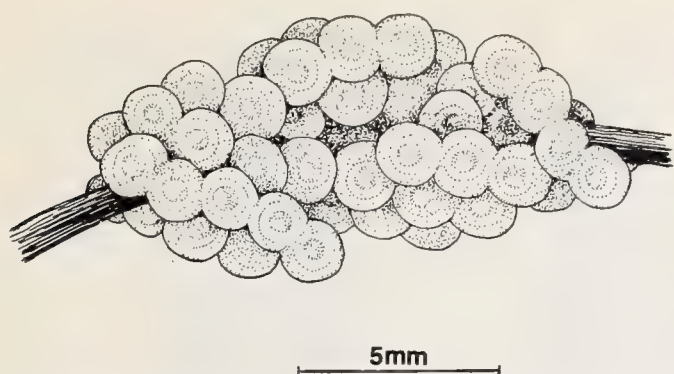


Plate 39. Egg mass of *Cerithium lutosum* Menke attached to *Ruppia* blade; Port Everglades, Florida.

Because of the variability in this species, a considerable synonymy exists. Menke's (1828) original description of *lutosum* based on material from Havana, Cuba, is brief and lacks a figure, but the small squat, dark shell he described does not apply to any other species from the Western Atlantic. Sowerby's (1855) and Reeve's (1865) figures of *C. lutosum* help to clarify Menke's description of this species. According to Zilch (1958), Menke's collection was dispersed in separate sales and most of his types are now lost. I have been unable to locate the type-material and so herein designate specimen 420395, USNM, from Havana, Cuba as the neotype. (Pl. 40).

I have examined a photo of the type of *Cerithium ferrugineum* described by Say (1832) from South Carolina and it is obviously Menke's species. *C. lutosum* has been long known as *C. variabile* C. B. Adams and appears in most recent works under this name. The paratypic series of Adams' *C. variabile* clearly demonstrates the color variability that exists in *C. lutosum*. The lectotype of *C. megasoma* C. B. Adams is obviously a beach-worn specimen of *C. lutosum*. *C. mutabile* C. B. Adams is a somewhat deformed specimen of the same. The lectotype of *C. versicolor*, which Weisbord (1962) and Abbott (1954) erroneously synonymized with *C. eburneum* Bruguière, is a light-colored form of *C. lutosum*. Sowerby made *C. mutabile* a synonym of *C. lutosum*. Reeve (1865) placed *C. variabile* and *C. versicolor* in the synonymy of *C. ferrugineum*. Examination

of the syntypes of *C. sagrae* Orbigny 1846 from Cuba (Pl. 42, fig. 6) has convinced me that this species is merely a squat, fat form of *C. lutosum*. Kobelt (1898) placed *C. megasoma* C. B. Adams (= *C. lutosum*) into the synonymy of *C. sagrae*. I have been unable to find the type material of *C. nigrinum* which was described by Philippi (1848) with no figure or type-locality. He subsequently (1851) illustrated his species, and both the figure and descriptions leave no doubt that Philippi's species is *C. lutosum*. Sowerby (1865) described three species, *C. rissoideae* (Pl. 42, fig. 5), *C. thomasiae* (Pl. 42, fig. 3) from St. Thomas, Virgin Islands, and *C. bermudae* (Pl. 41, fig. 8) from Bermuda. I have seen photographs of his types and they clearly indicate that these species are also synonyms of *C. lutosum*.



Plate 40. *Cerithium lutosum* Menke, neotype USNM 420395, Havana, Cuba.

Some forms of *C. lutosum* are smooth and the ground color may be white with branched axial stripes of brown or orange. A population like this from Bimini, Bahamas, was named *C. biminiense* by Pilsbry and McGinty in 1949 (Pl. 42, fig. 7). This is merely

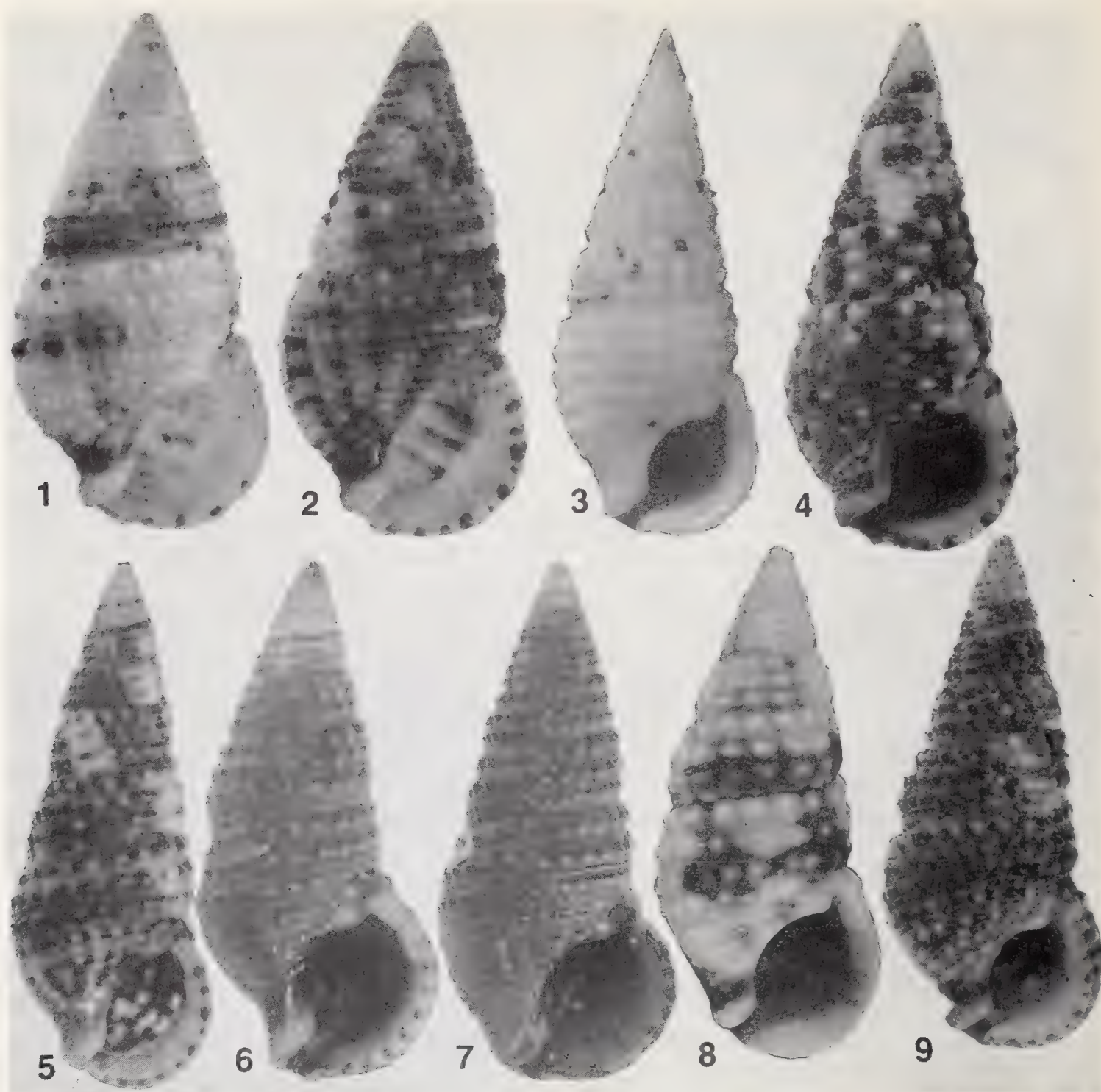


Plate 41. *Cerithium lutosum* Menke, showing variation in shell color and form. Fig. 1. St. Croix, Virgin Islands (13 mm); Fig. 2. Limon, Costa Rica (11.1 mm); Figs. 3-4. North end, Ascension Bay, Quintana Roo,

another color variation of *C. lutosum* which is smooth due to its rocky tide pool habitat and does not deserve the taxonomic status of species. A similar, but more deformed race occurs in Sweeting Pond, Eleuthera, Bahamas, and another occurs at Boca Raton, Florida (Pl. 42, fig. 8). Intergrades to typical *C. lutosum* forms are evident in all these populations.

Mexico (20 mm and 22.3 mm); Figs. 5-7. Port Everglades, Florida (14 mm, 10.2 mm and 12.3 mm); Fig. 8. *Cerithium bermudae* Sowerby, syntype BM(NH), Bermuda (11.3 mm); Fig. 9. Isle of Pines, Cuba (16 mm).

Mörch's description of *Cerithium alabastrum* was not accompanied with a figure, but a specimen in the Copenhagen Museum from St. Thomas, determined by Mörch as *C. alabastrum*, is probably the type. I have examined this shell and consider it to be *C. lutosum*.

Tryon (1887) placed *C. versicolor*, *C. variabile*, *C. nigrinum*, *C. bermudae*, *C.*

thomasiae and *C. lutosum* into the synonymy of *C. ferrugineum* while Dall (1889) made *C. ferrugineum* and *C. versicolor* synonyms of *C. variabile*. This indicates the confusion that has existed due to the great variability of *C. lutosum*. Specimens of *C. lutosum* examined in museum collections show con-

siderable geographic variation in shell color and width. Populations from rocky habitats are frequently worn and eroded and some may assume an almost smooth aspect with little trace of the usual tubercles or striations. Most populations are dark brown; a population from Port Everglades, Florida, is



Plate 42. *Cerithium lutosum* Menke, showing variation in shell color and form. Figs. 1-2. Ciudad Carmen, Campeche, Mexico (16.2 mm and 19.3 mm); Fig. 3. *Cerithium thomasiae* Sowerby, syntype BM(NH), St. Thomas Virgin Islands (9.3 mm); Fig. 4. Playa del Chivo, Havana, Cuba (7.9 mm); Fig. 5. *Cerithium ris-*

soidae Sowerby, holotype BM(NH), St. Thomas, Virgin Islands (7.1 mm); Fig. 6. *Cerithium sagrae* D'Orbigny, syntype BM(NH) 1954-10-392, Cuba (9.9 mm); Fig. 7. *Theridium biminiense* Pilsbry and McGinty, holotype ANSP 185468, Turtle Rocks, Bimini, Bahamas (12 mm); Fig. 8. Boca Raton, Florida (19.2 mm).

typical in this respect (Pl. 41, figs. 5-7). Populations from the Texas coast are characteristically light in color. Specimens in the Caribbean are frequently white with brown flecks, or of a mottled brown and white pattern. A population of giants averaging 20 mm in length, occurs in the Laguna de Terminos, Mexico (Pl. 42, figs. 1-2). I have also seen specimens with very large shells from Isla de Providencia in the Western Caribbean. Dwarf populations (8 mm in length) have been examined from the mainland of Honduras and Boca Raton, Florida.

Recent descriptions and figures of *C. lutosum* may be found in Abbott (1954), Perry and Schwengel (1955), Warmke and Abbott (1961) and Andrews (1971) under the name of *C. variable* C. B. Adams. The specimen illustrated by Webb (1942) as *C. variabilis* (p. 41, pl. 14, fig. 17) is *Batillaria minima*. Rice and Kornicker's (1962) figure of *C. variable* (p. 371, pl. 4, fig. 3) is *C. eburneum* Bruguière. As Bequaert (1942) has pointed out, *C. lutosum* is frequently confused with the potamidid snail *Batillaria minima*. The latter usually occurs with *C. lutosum* but is higher in the intertidal zone. Immature individuals of these two species are very difficult to separate. The operculum in *Batillaria minima* is multispiral and has a central nucleus. Bequaert's (1942) figure of *Batillaria minima rawsoni* Mörch (p. 10, pl. 5, figs. 8-10) is *C. lutosum*.

Fossil record. Although there are no recorded fossil records of *C. lutosum*, Jung (1969) has pointed out that *C. harrisi* Maury, 1912, from the Pliocene of Trinidad has the same sculpture as Recent Caribbean *C. variable* (= *C. lutosum*) but is longer, much heavier, and has a longer apical angle. Specimens of *C. harrisi* in the USNM are very like Recent *C. lutosum*. I have also seen specimens from the Florida Pinecrest Beds which appear to be *C. lutosum* or close relatives.

Range. From South Carolina and Ber-

muda south through the Bahamas, Florida, the Gulf of Mexico, and throughout the Caribbean to northern South America. Intertidal zone.

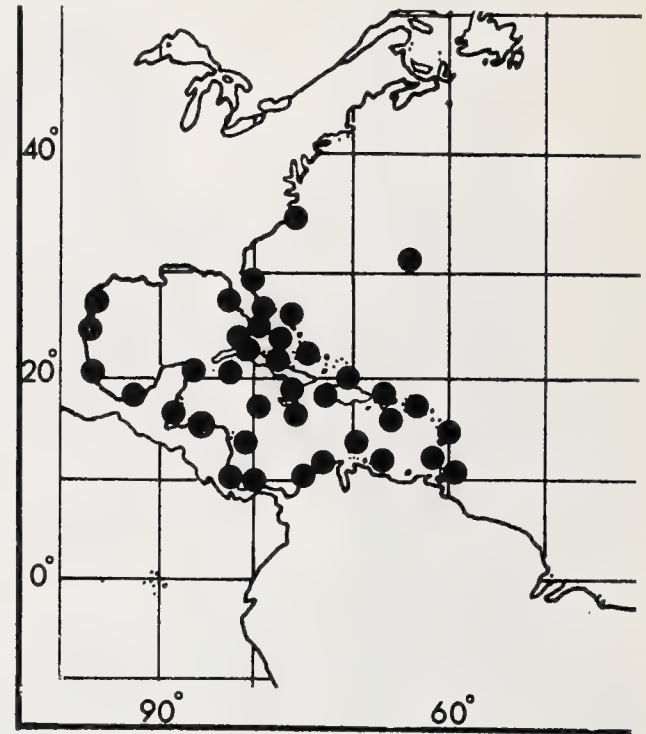


Plate 43. Geographical distribution of *Cerithium lutosum* Menke.

Specimens examined. SOUTH CAROLINA: (AMNH). FLORIDA: North Inlet, Lake Worth; Palm Beach Inlet (both AMNH); Palm Beach (USNM); Hillsboro Point (UMML); Boca Raton; Port Everglades (both USNM); Little River; Miami; Bear Cut, Key Biscayne (all UMML); Sand Key, Miami (USNM); North Key Largo (UMML); Key Largo Sound; E end Key Vaca; Bonefish Key (all AMNH); Old Rhodes Key; Upper Matecumbe Key (both UMML); Soldier Key (COP); Tortugas (UMML, USNM); Key West (USNM); Marco Island; Sanibel Island (both LACM); Terra Ceia, Tampa Bay (USNM); Gordon's Pass, Shell Key off St. Petersburg (USNM). TEXAS: Galveston (UMML); Sargent, Matagorda Bay; Matagorda Bay; Aransas Bay (all USNM); Port Aransas (MCZ); Corpus Christi Bay (USNM); Laguna Madre (COP); Port Isabel (MCZ). MEXICO: Vera Cruz, Vera Cruz; Ciudad Carmen, Campeche (both USNM); Isla Mujeres, Yucatán (USNM, ANSP); Isla Calcun, Quintana Roo (ANSP). BRITISH HONDURAS: Belize; E side of Tobacco Cay; Southwater Cay; Long Cay, Glover's Reef (all USNM). HONDURAS: (UMML); Puerto Cortez. COSTA RICA: Portete, Prov. Limón (both USNM). PANAMA: Colón (USNM); Coco Solo (LACM); San Blas Islands (USNM). BERMUDA: Entrance to Harrington Sound; Warwicke Parish; Great Sound, Somerset; Hamilton Harbor (all USNM); Burgess Point, Little Sound (AMNH). BAHAMAS: E end, Grand Bahama Island; Bimini (both AMNH); Alicetown, N Bimini (MCZ); Nassau, New Providence; off Mintie Bar, S E end South Bight, Andros Id.; Cockburntown, San Salvador; 3 mi.

up Lisbon Creek, Linder Key (all USNM); Sweetings Pond, Eleuthera (AMNH); Arthurstown, Cat Island (USNM); S Exuma Cay (ANSP); Salt Lagoon, Cay Sal; Bill Cay, E Caicos; E side of N W Point, Great Inagua (all USNM). CUBA: Cayo Huita Reef, Pinar del Río (USNM); Cojimar, Havana (ANSP); Cayo Norte, Río Santa Delta, Oriente; Bahía de los Cochinos, Las Villas (both USNM); Isle of Pines (USNM, COP). JAMAICA: Kingston (AMNH); Montego Bay; Green Island Harbour, Hanover (both USNM). HAITI: Port-au-Prince (USNM); Cape Haitien (UMML); Tiburon; Les Cayes, Dept. de Sud (both USNM). DOMINICAN REPUBLIC: Monti Christi (AMNH); Lago de Enriquillo (USNM). LESSER ANTILLES: St. Croix; St. John; St. Thomas; St. Martin (all COP); Guadeloupe; St. Vincent (both ANSP); Oyster Pond Landing, Barbuda (USNM); Needham Point, Barbados (both USNM); Tobago; Trinidad; Dry Rocks, Bucco Reef, Tobago (USNM). CARIBBEAN ISLANDS: Grand Cayman Island (ANSP); Palmetto Point, W shore, Grand Cayman Id. (AMNH); Curaçao (AMNH); Aruba (ANSP). COLOMBIA: Santa Maria (ANSP); Baranquilla (USNM). VENEZUELA: Cubagua Island (USNM).

Cerithium (Thericium) muscarum Say Plates 44-48

Cerithium muscarum Say 1832. Amer. Conch., no. 5; pl. 49, fig. 1 (southern shores of Florida, here restricted to Mullet Key, Tampa Bay, Florida; type not found; Say's figure here designated to represent the lectotype); Sowerby, 1855. Thes. Conch., 2: 862., pl. 180, figs. 108, 109, 110; Reeve, 1865. Conch. Icon, 15, *Cerithium*: sp. 67, pl. 10, fig. 67; Tryon, 1887. Man. Conch., 9: 132, pl. 23, figs. 12, 13; Smith, M., 1937. East Coast Marine Shells, p. 106, pl. 38, fig. 12; Perry, 1940. Bull. Amer. Paleont., 26(95): 132, pl. 27, fig. 198; Morris, 1951. A Field Guide to the Shells, p. 159, pl. 32, fig. 3 (left fig. only, right is *C. atratum* Born); Abbott, 1954. American Seashells, p. 154, pl. 19m; Perry and Schwengel, 1955. Marine Shells of the Western Coast of Florida, p. 142, pl. 27, fig. 198; Abbott, 1968. Seashells of North America, pp. 88, 89, fig. 9.

Cerithium callisoma Dall 1890. Trans. Wagner Free. Inst. Sci. Phila., 3(2): 282, pl. 14, fig. 8. (Pliocene; Caloosahatchee beds, Florida; holotype, USNM 113363).

Cerithium muscarum Say var. *protracta* Vignal 1902. Jour. de Conch., 49(4): 305, pl. 8, figs. 9, 10 (no locality given; type not seen).

Cerithium (Thericium) chara Pilsbry 1949. Nautilus, 63(1): 65, 66, pl. 1, figs. 11, 12. (7 mi. off Hudson, Florida in 3 fms.; holotype ANSP 185477; paratypes ANSP 185477).

Cerithium (Thericium) muscarum Say. Olsson and Harbison, 1953. Acad. Nat. Sci. Phila., Mongr. no. 8, pp. 284, 285, pl. 42, fig. 9.

Description. Shell reaching 26 mm in length, average 18 mm, moderately elongate,

slender, with 9-11 whorls in adult specimens. Protoconch glassy, 2+ whorls and usually missing in adults. Sculpture of 9-11 nodulated distinct axial ribs per whorl and 4-5 distinct prominent spiral cords interspaced with spiral striae. These pass over the axial ribs and form knobs or beads giving the ribs a crenate appearance. There are 5 spiral cords on the body whorl. Base of shell excavated, concave, usually smooth or marked with small spiral striae and with a strong spiral cord, often nodulated. Several varices usually scattered along the spire, the strongest opposite the aperture. Sutures deep, distinct. Aperture ovate, outer lip thin, crenulate; columella usually lacking a callus. Anal canal weakly developed with a small but distinct sinus. Siphonal canal prominent, long and twisted to left. Color ranging from white to dark brown, usually gray; spiral striae bear red-brown spots forming rows. Nodes on axial ribs usually white. Operculum corneous, yellow-brown, thin, ovate and paucispiral with an eccentric nucleus. Periostracum not evident. Radula 2-1-1-1-2. Animal maculated with brown-gray and tiny white spots, color more prominent on upper portion of head, snout, and foot. Gonadal ducts open; males with spermatophore organ at distal end of pallial gonoduct. Reproduction oviparous; egg mass consists of compactly folded, tightly coiled filaments. Egg

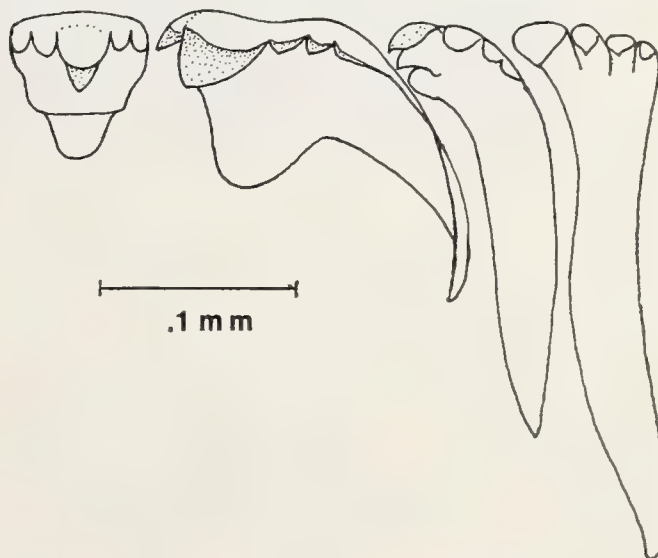


Plate 44. *Cerithium muscarum* Say from Mullet Key, Tampa Bay, Florida. Radula, half-row.

capsules arranged in pairs within filaments, each capsule containing a single yolky ovum; hatching occurs when larvae are about two weeks old and crawling.

length	width	no. whorls	
26 mm	7 mm	12	Crystal River, St. Joseph's Sound, Florida
22	7	11	Isle of Pines, Cuba
21	8	10	Monroe Park, Key West, Florida
20	7	10	Peanut Island, Lake Worth, Florida
18	6	10	Santa Lucia, N.W. Cuba, 2-4 fms.
9	4	7	Banana River, Cocoa, Florida
8	5+	9	Progreso, Yucatan

Remarks. This species is distinguished by its many prominent axial ribs and spiral striae which give it a crenulate appearance. The strong spiral cord at the base of the shell and the long siphonal canal are also distinguishing characters.

Cerithium muscarum is usually associated with marine angiosperm grasses (*Thalassia*, *Ruppia*, *Halodule*) and is a common intertidal estuarine species throughout its range. It occasionally occurs subtidally where it is often found together with *C. eburneum*. It is a euryhaline species and frequently is found in brackish environments. Living populations observed in Florida ate detritus and algae such as *Cladophora* and *Chaetomorpha*. They exhibited seasonal reproductive activity; males produced spermatophores and oviposition occurred from late winter throughout the spring (Houbrick, 1974b). The egg masses of *C. muscarum* (Pl. 45) are very distinctive and are deposited in tightly coiled filaments which are compactly folded to constitute spherical masses 15-30 mm in diameter. Individual capsules are arranged in pairs within the filaments (Houbrick, 1974c). The eggs are large and the young emerge in the crawling stage (Pl. 46, c). Hatching of young snails takes place in about two weeks and the juveniles grow to adult stages in a few months. The life span is about one year (Houbrick, 1974b).

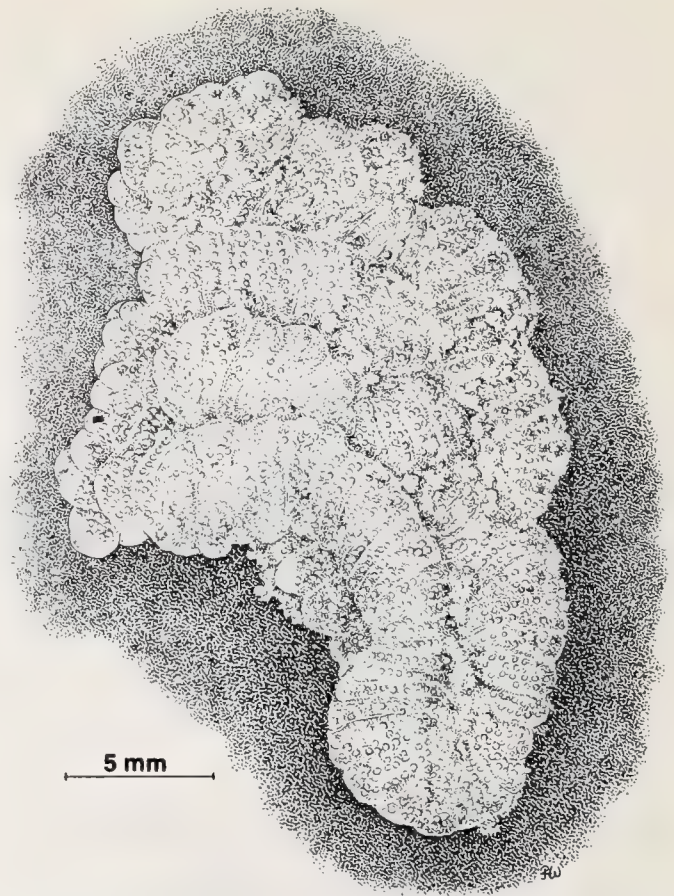


Plate 45. Egg mass of *Cerithium muscarum* Say from Marco Island, Florida, typical of *Cerithium* species without free-swimming larval stages.

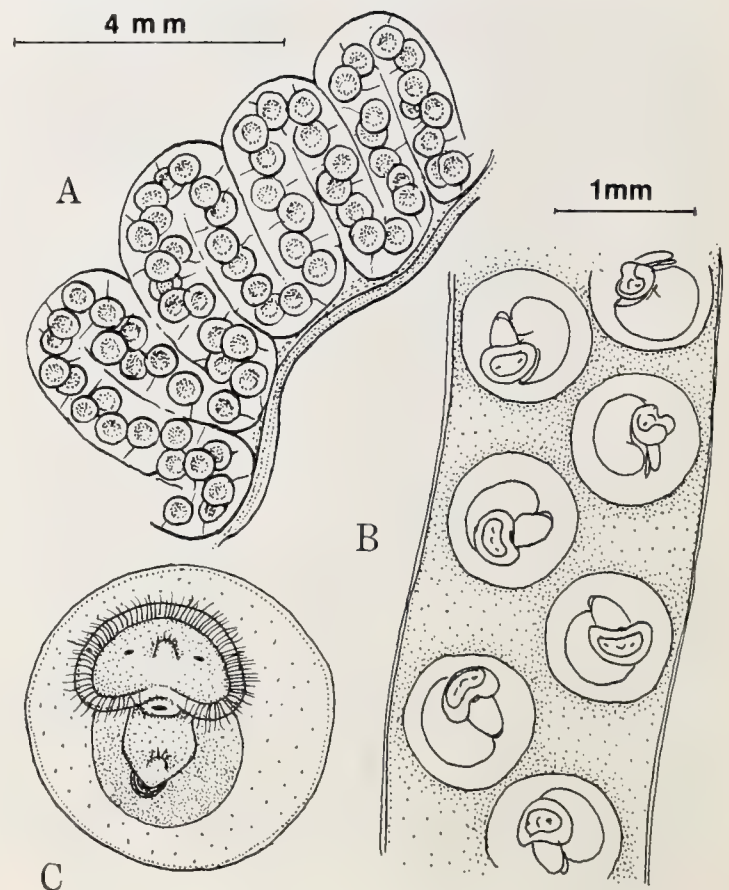


Plate 46. Portion of egg mass and developing larvae of *Cerithium muscarum* Say, from Mullet Key, Tampa, Bay, Florida. A. Portion of egg filament with enclosed zygotes; B. 9 day-old larvae within egg capsules in filament of egg string; C. 10 day-old encapsulated larva at veliger stage.

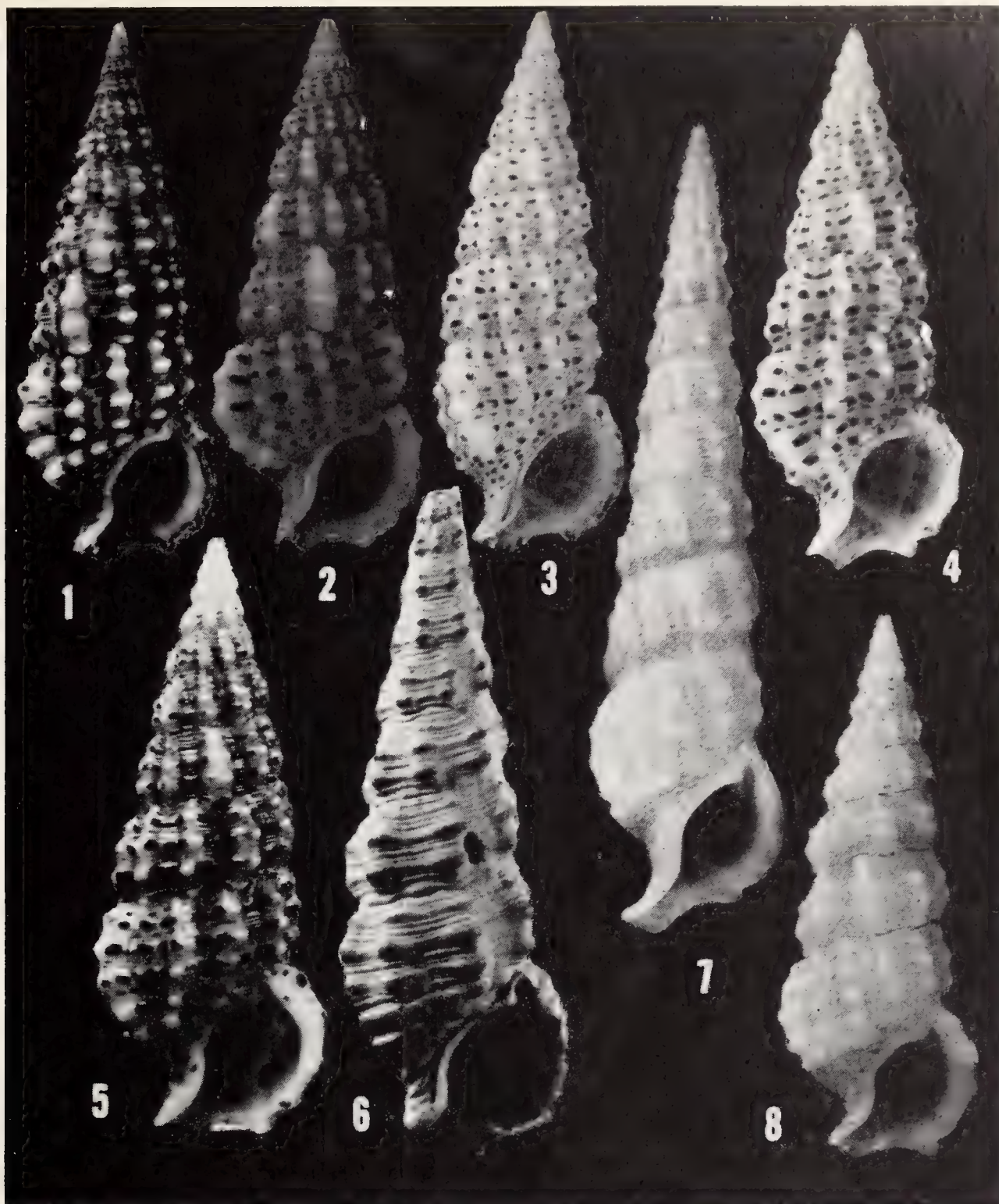


Plate 47. *Cerithium muscarum* Say. Figs. 1-3. Turkey Point, Dade Co., Florida (21.2 mm, 21 mm and 20 mm); Fig. 4. Crystal Beach, Pinellas Co., Florida (23 mm); Fig. 5. Mullet Key, Tampa Bay, Florida (26 mm);

Say's original description of *muscarum* was based upon material from "the southern shores of Florida." I was unable to locate the holotype, but Say's original description and figure adequately represent this species. The original type-material appears to be lost; I herein designate Mullet Key, Tampa Bay,

Fig. 6. *Cerithium callisoma* Dall (26 mm); Fig. 7. *Cerithium chara* Pilsbry, paratype ANSP 185477, 7 mi. off Hudson, Pasco Co., Florida (22.3 mm); Fig. 8. Pine Island, Hernando Co., Florida (19 mm).

Florida as the type-locality and Say's figure to represent the lectotype.

Dall himself noted the similarity between his species, *C. callisoma* Dall, 1890 (Pl. 47, fig. 6), from the Pliocene of the Caloosahatchee, and *C. muscarum*. The minor sculptural differences he mentions do not appear

sufficient for specific distinction.

A slender form of *C. muscarum*, which Pilsbry (1949) elevated to specific level and named *C. (Theridium) chara*, occurs offshore of Hudson, west Florida (Pl. 47, fig. 7). Pilsbry noted the close resemblance of his species to *C. muscarum*; I have examined the type-material and additional slender specimens from Crystal Beach, Anclote Key, Tarpon Springs, Bayport, and Cedar Keys, and am of the opinion that these populations are merely ecophenotypes or genetic races which do not merit the rank of species. Moreover, slender morphs like Pilsbry's *C. chara* also occur among populations from Bimini and Abaco, Bahamas, and from lower Biscayne Bay, and Big Pine Key, Florida; consequently the Hudson population cannot be regarded as being of sub-specific status.

Vignal's (1902) variety, *C. muscarum protracta*, is merely another morph with more varices and ribs and was described without sufficient comparative material.

Perry (1940) illustrated *C. muscarum* using 2 specimens which constitute a mixture of the former and *C. atratum*. The shell on the right is *C. atratum* (Born).

Collections of *C. muscarum* from all parts of its range do not show as much variation in shell sculpture and size as one encounters in other species of *Cerithium*. I have examined dwarf populations from the Indian River near Rockledge and Cocoa, Florida, where adult specimens range from 8-10 mm in length. The species appears to attain its maximal size on the west coast of Florida, especially near Tampa Bay, where adults are about 24 mm in length (Pl. 47, fig. 5).

Fossil record. *C. muscarum* has a geological range from the Pliocene of Florida, where it is a common fossil, to the Recent. I agree with Olsson and Harbison (1953) who believed that the Pliocene species, *C. litharium* Dall and *C. triticum* Dall were related to *C. muscarum*. Dall (1890) noted the relationship of *C. callisoma* Dall and *C. glaphyrea* Dall to *C. muscarum* and I agree

with him that *C. praecursor* Heilprin is the ancestor of *C. muscarum*. DuBar (1958) reported *C. muscarum* to be common in the Fort Thompson formation of Florida and rare in the Caloosahatchee marl. It also occurs on the "Glades" unit of southern Florida (McGinty, 1970).

Range. *C. muscarum* has the most limited distribution of all the western Atlantic *Cerithium* species: North Carolina south to the Bahamas and Cuba, with one questionable record from Jamaica; most common in west Florida and is found throughout the Gulf of Mexico from Texas south to the Yucatan peninsula where it reaches the Caribbean at Quintana Roo, Mexico. A questionable record of Bermuda was cited by Clench [*in*] Moore and Moore (1946). Depth range to 10 m.

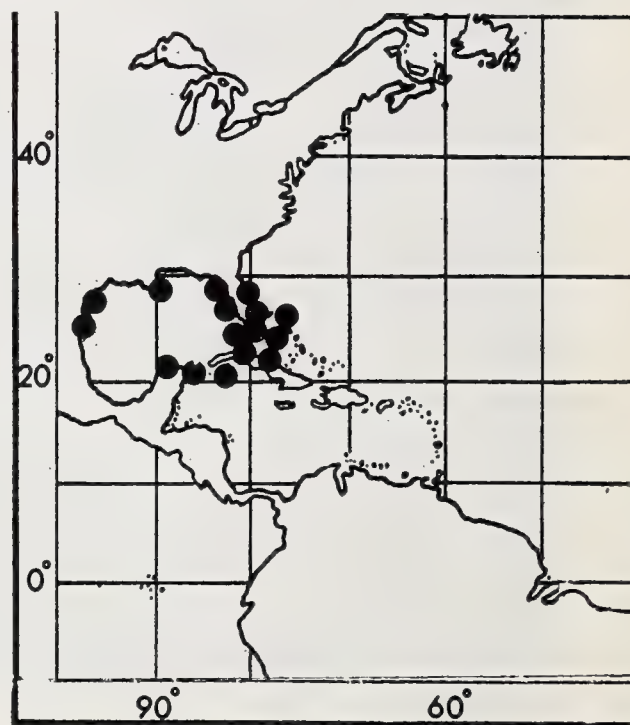


Plate 48. Geographical distribution of *Cerithium muscarum* Say.

Specimens examined. NORTH CAROLINA: Ocracoke (ANSP). FLORIDA: St. Augustine (MCZ); Cocoa Beach (AMNH); Banana River, Cocoa Causeway (USNM); Rockledge (ANSP); Indian River (UMML); Ft. Pierce (ANSP); Stuart (USNM); Jensen Beach (AMNH); North Inlet, and Peanut Island, Lake Worth (both AMNH); Ft. Lauderdale (ANSP); Fisher's Island, Miami (USNM); Key Largo, S. side; Ohio Key (both AMNH); Pigeon Key (USNM); Big Pine Key (ANSP); Garden Key, Tortugas (USNM); Flamingo, Monroe Co. (AMNH); Marco Island (MCZ); Sanibel Island (AMNH); Captiva Island (COP); Punta Gorda; Ft.

Myers (both AMNH); Charlotte Harbor (ANSP); Boca Ciega Bay; Gulfport; Pass-a-Grille (all USNM); St. Petersburg Beach (AMNH); Mullet Key, Tampa Bay; Old Tampa Bay (both USNM); Tarpon Springs (AMNH); Crystal Beach; Dunedin; Pine Island, Hernando Co.; 7 mi. off Hudson; Crystal River (all USNM); Cedar Keys (USNM:AMNH). LOUISIANA: Chauvin (AMNH); N. Sable Island (MCZ). TEXAS: St. Joseph Bay (AMNH). MEXICO: Cerro Island, Cienega, near Progreso, Yucatán (MCZ); Isla Calcun, Quintana Roo (ANSP); saline lagoon near Progreso (USNM). BAHAMAS: Great Abaco Island (UMML); Angel Fish Point, Little Abaco (MCZ); Andros Island; Bimini (both ANSP). CUBA: Cayo Huita Reef, Pinar del Rio; Santa Lucia (both USNM); Havana, Havana (AMNH); Cárdenas Bay, Matanzas (USNM); Península de Huicaicos, Matanzas (AMNH); Muella, Caribarién, Matanzas; Punta Alegre, Camagüey (both MCZ); Terroplen, Turigano Island, Camagüey; Bahía Malajeta, Oriente (both USNM); Cayo Francis, Las Villas (USNM; MCZ); Isle of Pines (AMNH). JAMAICA: (USNM)?

LIST OF DOUBTFUL SPECIES OF *CERITHIUM*

This section contains names of western Atlantic *Cerithium* species that I consider to be uncertain, unrecognizable or possibly belonging to other genera.

Cerithium antillarum "Dunker" Mörch 1876. Malak. Blätt., 23: 112-113 (type not located; Guadeloupe, Jamaica [Sowerby], Cuba [Dunker])

This species was described by Mörch with a manuscript name of Dunker's but was not figured. Mörch referred to Sowerby's (1855) figures of the Panamic species, *Cerithium uncinatum* (Gmelin). He also cited Sowerby and Dunker in giving Guadeloupe, Jamaica and Cuba as localities. *Cerithium atratum* (Born) is virtually indistinguishable from *C. uncinatum* and the latter may be the Panamic cognate or a synonym of *C. atratum*. Mörch noted that *C. antillarum* differed slightly from *C. famelicum* C. B. Adams, a synonym of *C. uncinatum*. If *C. antillarum* is truly from the West Indies it is probably a synonym of *C. atratum*.

Cerithium alabastrulum Mörch 1876. Malak. Blätt., 23: 121 (St. Thomas; type not found)

This is a *Bittium* sp. It was described from a small shell (6 mm) but the description lacks a figure. Some of Mörch's types are in the Copenhagen Museum and I have seen material labeled by Mörch as *alabastrulum* which may constitute the type lot.

Cerithium eriense "Valenciennes" Kiener 1841. Coquilles vivantes, pt. 1, p. 59, pl. 24, fig. 1 (no locality given; type not found)

This species was placed into the synonymy of *Batillaria minima* by Bequaert (1942) but Kiener's figure as well as the figures in Reeve (1865. Conch. Icon., vol. 15, pl. 9, fig. 55) and Sowerby (1855. Thes. Conch., vol. 2, pl. 181, fig. 119) look more like *C. lutosum* Menke, and I suspect that *C. eriense* is a synonym of *C. lutosum*.

Cerithium guaranianum Orbigny 1841. Voy. Amér. Mérid., 7:433, no. 376, pl. 77, figs. 11, 12 (Rio de Janeiro; type not found)

The concept of this species, described from a small specimen (3 mm), remains unclear. Orbigny's figure is not a good rendering, but looks like an immature *C. atratum* or a *Cerithiopsis* sp.

Cerithium lentiginosum Sowerby [in] Reeve 1865. Conch. Icon., 15: Sp. 77, pl. 11, fig. 77 (no locality given; type not found)

Reeve's figures closely resemble *C. eburneum* Bruguière and *C. muscarum* Say, but no locality was given and the species is still doubtful.

Cerithium (*Bittium*?) *oryza* Mörch 1876. Malak. Blätt., 23: 121 (St. Thomas; type not found)

This species, as indicated by Mörch, is probably a *Bittium* sp.

Cerithium punctulatum (Gmelin) [In] Linnaeus 1791. Syst. Nat. (ed. 13) 1(6): 3503, no. 151. (no locality given; type not found)

Gmelin referred to Lister (Synop. Conch., pl. 979, fig. 38, 1685) for a figure of his species, but Lister's rendering of the figure is of poor quality and does not serve to clarify Gmelin's species.

LITERATURE CITED

- Abbott, R. T. 1954. American Seashells. New York. 541 p., 46 pls.
Abbott, R. T. 1958. The marine mollusks of Grand Cayman Island, British West Indies. Acad. Nat. Sci. Phila. Monogr. 11, 138 p., 5 pls.
Abbott, R. T. 1962. Seashells of the world. New York, 160 p.
Adanson, M. 1757. Histoire naturelle du Sénégal. Coquillages. Illust. Paris. 275 p., 19 pls.
Andrews, J. 1971. Sea shells of the Texas coast. University of Texas Press, Austin. 295 p.
Anton, H. E. 1839. Verzeichniss der Conchylien welche sich in der Sammlung von Hermann Eduard Anton befinden. Halle. xvi + 110 p.

- Bequaert, J. C. 1942. *Cerithidea* and *Batillaria* in the western Atlantic. *Johnsonia* 1(5): 1-12.
- Born, I. 1780. *Testacea musei Caesarei Vindobonensis*. Vienna. xxxvi+442+17 p., 18 pls.
- Bouvier, E. L. 1887. Système nerveux, morphologie générale et classification des gastéropodes prosobranches. *Ann. Sci. Nat. Zool.* 7(3): 1-510.
- Briggs, J. 1970. A faunal history of the north Atlantic Ocean. *Syst. Zool.* 19(1): 19-34.
- Bruguère, J. G. 1789; 1792. *Encyclopédie Méthodique, Histoire Naturelle des Vers*. Paris. Vol. 1. (1): 1-344, 1789; (2): 345-757, 1792.
- Cernohorsky, W. O. 1972. *Marine shells of the Pacific*. Vol. 2. Pacific Publications, Sydney. 411 p.
- Chesher, R. H. 1966. Redescription of the echinoid species *Paraster floridiensis* (Spatangoida: Schizasteridae). *Bull. Mar. Sci.* 16: 1-19.
- Clench, W. J. and R. D. Turner. 1950. The western Atlantic marine mollusks described by C. B. Adams. *Occ. Pap. Moll.* 1(15): 233-403, 49 pls.
- Coomans, H. E. 1958. A survey of the littoral gastropoda of the Netherlands Antilles and other Caribbean islands. *Stud. Fauna Curaçao Carib. Islds.* 31: 42-111, 16 pls.
- Cossmann, M. 1889. Coquilles Fossiles de L'Eocene des environs de Paris. *Soc. Roy. Malacol. Belgique* 24(4): 1-385, 11 pls.
- Cossmann, M. 1906. *Essais de paléoconchologie comparée*. Paris. 261 p., 14 pls.
- Dall, W. H. 1889. A preliminary catalogue of the shell-bearing marine mollusks and brachiopods of the south-eastern coast of the United States. *U.S. Nat. Mus. Bull.* 37, 221 p., 74 pls.
- Dall, W. H. 1890. Tertiary fauna of Florida. Part I. Pulmonate, opisthobranchiate and orthodont gastropods. *Trans. Wagner Free Inst. Sci. Phila.* 3(1): 1-200, pls. 1-12.
- Dall, W. H. 1892. Tertiary fauna of Florida. Part II. Streptodont and other gastropods. *Trans. Wagner Free Inst. Sci. Phila.* 3(2): 201-473, pls. 13-22.
- Dall, W. H. 1907. A new *Cerithium* from the Florida Keys. *Nautilus* 21(2): 22-23.
- Dall, W. H. 1915. A monograph of the molluscan fauna of the *Orthaulax pugnax* zone of the Oligocene of Tampa, Florida. *U.S. Nat. Mus. Bull.* 90, 173 p., 26 pls.
- D'Asaro, B. 1969. The comparative embryogenesis and early organogenesis of *Bursa corrugata* Perry and *Distorsio clathrata* Lamarck (Gastropoda: Prosobranchia). *Malacologia* 9(2): 349-389.
- Dautzenberg, P. 1912. Mollusques marins mission Gruvel sur la côte occidentale d'Afrique (1909-10). *An. Inst. Oceanogr. Monaco* 5(3): 1-111.
- Davis, G. M. 1971. Systematic studies of *Brotia costula episcopalis*, first intermediate host of *Paragonimus westermani* in Malaysia. *Proc. Acad. Nat. Sci. Phila.* 123(3): 53-86.
- Dazo, B. C. 1965. The morphology and natural history of *Pleurocera acuta* and *Goniobasis livescens* (Gastropoda: Prosobranchia) (Cerithiacea: Pleuroceridae). *Malacologia* 3(1): 1-80.
- Deshayes, G. P. 1843. [in] Lamarck. *Hist. Nat. Anim. sans Vert.*, ed. 2, 9: Cérîte, p. 280-342.
- DuBar, J. R. 1958. Stratigraphy and paleontology of the late Neogene strata of the Caloosahatchee River area of southern Florida. *Fla. Geol. Surv. Bull.* 40: 242 p., 12 pls.
- Fischer-Piette, E. 1942. Les mollusques d'Adanson. *Journ. de Conchyliol.* 85(2-3): 103-377, 16 pls.
- Fretter, V. 1951. Observations on the life history and functional morphology of *Cerithiopsis tuberculatus* and *Triphora perversa*. *J. Mar. Biol. Assoc. U.K.* 29: 567-586.
- Fretter, V. and A. Graham. 1962. *British prosobranch mollusks*. Ray Society, London. 755 p.
- Gabb, W. M. 1881. Descriptions of new species of fossils from the Pliocene clay beds between Limon and Moen, Costa Rica, together with notes on previously known species from there and elsewhere in the Caribbean area. *Jour. Acad. Nat. Sci. Phila. Ser. 2*, 8(4): 349-380.
- Gardner, J. 1945. Mollusca of the Tertiary formations of northeastern Mexico. *Geol. Soc. Amer. Mem.* 11, 332 p., 24 pls. 1 map.
- Grant, U. S. and B. H. R. Gale. 1931. Catalogue of the marine Pliocene and Pleistocene mollusca of California and adjacent regions. *San Diego Soc. Nat. Hist. Mem.* Vol. 1, 1036 p., 32 pls.
- Gregory, J. W. 1895. Contributions to the paleontology and physical geology of the West Indies. *Quart. J. Geol. Soc.* 51: 255-310, pl. 11.
- Hedley, C. 1899. The mollusca of Funafuti, Pt. 1; Gastropoda. *Mem. Australian Mus.* 3(7): 436-437.
- Heilprin, A. 1887. Explorations on the west coast of Florida and in the Okeechobee Wilderness. *Trans. Wagner Free Inst. Sci. Phila.* 1: 365-506, pls. 54-74.
- Hoerle, S. 1972. Cerithiidae and Potamididae (Mollusca: Gastropoda) from the Chipola Formation of northwestern Florida. *Tulane Stud. Geol. Paleont.* 10(1): 1-22.
- Houbrick, J. 1970. Reproduction and development in Florida *Cerithium*. *Amer. Malac. Union Inc. Ann. Rep.* 1970: 74.
- Houbrick, J. R. 1971. Some aspects of the anatomy, reproduction, and early development of *Cerithium nodulosum* (Bruguère) (Gastropoda: Prosobranchia). *Pacific Sci.* 25(4): 560-561.
- Houbrick, R. 1974a. Application to preserve the name *Cerithium* by designating *Cerithium adansonii* Bruguère, 1792 as the type-species. *Bull. Zool. Nomenclature.* 30(2): 104-107.
- Houbrick, R. 1974b. Growth studies on the genus *Cerithium* (Gastropoda: Prosobranchia) with notes on ecology and microhabitats. *Nautilus* 88(1): 14-27.
- Houbrick, R. 1974c. Studies on the reproductive biology of the genus *Cerithium* (Gastropoda: Prosobranchia) in the western Atlantic. *Bull. Mar. Sci.* 23(4): 875-904.
- Iredale, T. 1930. Queensland molluscan notes, No. 2. *Mem. Qld. Museum* 10(1): 73-88, 1 pl.
- Joannis, L. de. 1834. Sur l'animal de *Cerithium vulgatum*. *Mag. Zool.* 4(5): 52.

- Johansson, J. 1947. Über den offenen Uterus bei einigen Monotocardiern ohne Kopulationsorgan. Zool. bidrag. Upsala. 25: 102-110.
- Johansson, J. 1953. On the genital organs of some mesogastropods: *Cerithium vulgatum* Brug., *Triphora perversa* (L.), and *Mellanella (Eulima) intermedia* (Cantr.). Contributions to the phylogeny of the pallial gonoducts of the prosobranchia. Zool. bidrag. Upsala. 30: 1-23.
- Johansson, J. 1956. On the anatomy of *Tympanotonus fuscatus* (L.) including a survey of the open pallial oviducts of the Cerithiaceae. Atlantide Rep. 4: 149-166.
- Jung, P. 1969. Miocene and Pliocene mollusks from Trinidad. Bull. Amer. Paleont. 55(247): 293-657, 59 pls.
- Kiener, L. C. 1841-42. Spécies général et iconographie des coquilles vivantes, etc. Vol. 5, Genre Cerite. 104 p., 32 pls.
- Keen, M. 1971. Sea Shells of Tropical West America. Second Ed. Stanford Univ. Press, Stanford. 1064 p.
- Kobelt, W. 1898. [in] Martini, F. H. W. and J. H. Chemnitz. Neues systematisches Conchylien-Cabinet etc. 1(26) *Cerithium*, 297 p., 47 pls.
- Lamarck, J. B. 1799. Prodrome d'une nouvelle classification des coquilles. Paris Soc. Hist. Nat. Mém. 1: 63-91.
- Lamarck, J. B. 1810. Système Animaux sans Vertèbres, Paris. 432 p.
- Lister, M. 1685 [-1692]. Historiae sive synopsis methodicae conchyliorum. London.
- MacNeil, F. S. 1960. Tertiary and Quaternary gastropoda of Okinawa. U.S. Geol. Surv. Prof. Pap. 339: 1-148, 19 pls.
- Mansfield, W. C. 1930. Miocene gastropods and scaphopods of the Choctawatchee Formation of Florida. Fla. State Geol. Sur. Bull. No. 3: 1-185, 21 pls.
- Marcus, E. and E. Marcus. 1964. On *Cerithium atratum* (Born, 1778). Bull. Mar. Sci. 14(3): 494-510.
- Martyn, T. 1784-92. The Universal Conchologist, 4 vols. Illust. London. 39 pp. 160 pls.
- Matthews, H. R. 1967. Primeira contribuição ao inventário dos moluscos marinhos do nordeste Brasileiro. Arq. Estac. Biol. Mar. Univ. Ceará 7(1): 67-77.
- Maury, C. J. 1917. Santo Domingo type sections of Fossils, Pt. 1: Mollusca. Bull. Amer. Paleont. 5(29): 165-415.
- Maury, C. J. 1920. Tertiary mollusca from Puerto Rico. N. Y. Acad. Sci. Scienc. Surv. Puerto Rico and Virgin Islands 3(1): 1-77, 9 pls.
- Mayr, E. 1966. Animal Species and evolution. Harvard Univ. Press, Mass. 797 p.
- Mayr, E. 1969. Principles of Systematic Zoology. McGraw-Hill, New York, 428 p.
- McGinty, T. 1970. Mollusca of the "Glades" unit of southern Florida, Pt. 1, Introduction and observations. Tulane Stud. Geol. Paleont. 8(2): 53-68.
- Menke, K. T. 1828. Synopsis Methodica molluscorum generum omnium et speciarum earum quae in Museo Menkeana adservabitur . . . Pyrmont, Germany. xxi + 91 p.
- Monterosato, M. 1890. Il naturalista Siciliano 9(7): 140-151; 157-166.
- Montfort, D. de. 1808-10. Conchyliologie systématique: et classification méthodique des coquilles etc. Vol. 1, Illust. Paris. 676 p.
- Moore, H. B. and D. M. Moore. 1946. Preglacial history of Bermuda. Bull. Geol. Soc. Amer. 57: 207-222.
- Mörch, O. A. L. 1876. Synopsis molluscorum marinarum Indianarium occidentalium. Malak. Blätt. 23: 87-143.
- Morris, P. 1951. A field guide to the Shells of our Atlantic and Gulf coasts. Boston. 236 p., 45 pls.
- Morrison, J. P. 1954. The relationships of old and new world Melanians. U. S. Nat. Mus. Proc. 103 (3325): 357-394.
- Nicklès, M. 1950. Mollusques testacés marins de la côte occidentale d'Afrique. Manuels Ouest-Africains 2: 1-269.
- Nordsieck, F. 1968. Die europäischen Meeres-Gehäuseschnecken (Prosobranchia). Fischer Verlag, Stuttgart. 273 p.
- Olsson, A. A. and A. Harbison. 1953. Pliocene mollusca of southern Florida. Acad. Nat. Sci. Phila. Monogr. 8: 1-457, 65 pls.
- Parker, R. H. and J. R. Curran. 1956. Fauna and bathymetry of banks on continental shelf, northwest Gulf of Mexico. Bull. Amer. Ass. Petrol. Geol. 40(10): 761-773, 1 pl.
- Peile, A. J. 1926. The mollusca of Bermuda. Proc. Malac. Soc. Lond. 17(2-3): 71-98.
- Perry, L. M. 1940. Marine shells of the southwest coast of Florida. Bull. Amer. Paleont. 26(95): 1-120, 39 pls.
- Perry, L. M. and J. S. Schwengel. 1955. Marine shells of the western coast of Florida. Paleontological Research Inst., Ithaca, New York. 318 p., 55 pls.
- Philippi, R. A. 1848. Testaceorum novorum centuria. Zeits. für Malak. 20: 2-32.
- Philippi, R. A. 1849. Abbildungen und Beschreibungen neuer oder wenig gekannter Conchylien 3(4), *Cerithium*, p. 13-20.
- Pilsbry, H. A. 1921. Revision of W. M. Gabb's Tertiary mollusca of Santo Domingo. Proc. Acad. Nat. Sci. Phila. 73: 353-416, figs. 17-40.
- Pilsbry, H. A. 1949. New Cerithiidae from Florida. Nautilus 63(2): 65-66, pl. 1.
- Pilsbry, H. A. and T. L. McGinty. 1949. New marine mollusks of Florida and the Bahamas. Nautilus 63(1): 9-15, pl. 1.
- Reeve, L. A. 1865. Conchologia Iconica: or illustrations of the shells of molluscos animals. Vol. 15, *Cerithium*, 20 pls. + index.
- Rehder, H. A. 1940. Note on *Theridium auricoma* Schwengel and *stantoni* Dall. Nautilus 54(2): 72-73.
- Rice, W. H. and L. S. Kornicker. 1962. Mollusks of Alacran reef, Campeche Bank, Mexico. Publs. Inst. Mar. Sci. Univ. Texas 8: 366-402, 9 pls.
- Rios, E. C. 1970. Coastal Brazilian Seashells. Fundação Cidade do Rio Grande. Museu Oceanográfico de Rio Grande. 255 p., 60 pls.

- Risbec, J. 1943. Recherches anatomiques sur les prosobranches de Nouvelle-Calédonie. Pt. 4. Ann. Sci. Natur. Zool. (Ser. II) 5: 89-112, 5 pls.
- Risbec, J. 1955. Considérations sur l'anatomie comparée et la classification des gastéropodes prosobranches. Journ. de Conchyliol. 95: 45-82.
- Rosewater, J. 1970. The family Littorinidae in the Indo-Pacific. Pt. 1, The Subfamily Littorininae. Indo-Pacif. Mollusca 2(11): 417-528.
- Say, T. 1832. American Conchology, or descriptions of the shells of North America. New Harmony, Indiana, no. 5, pl. 49.
- Schwengel, J. 1940. Two new Floridan marine shells. Nautilus 53(4): 109-110, 1 pl.
- Smith, E. A. 1890. Mollusca of Fernando de Noronha. Jour. Linn. Soc. 22: 483-503.
- Smith, M. 1946. New Caribbean and Panamic shells and a Pliocene *Marginella*. Nautilus 60(2): 60-62, pl. 6.
- Sohl, N. F. 1960. Archaeogastropoda, Mesogastropoda and stratigraphy of the Ripley, Owl Creek, and Prairie Bluff Formations. U. S. Geol. Surv. Prof. Pap. 331-A: 1-151, 18 pls.
- Sowerby, G. B. 1855. Thesaurus conchyliorum, or monographs of genera of shells. Vol. 2, *Cerithium*, p. 847-859, pls. 176-186.
- Sowerby, G. B. 1865. [in] Reeve, Conchologia Iconica: or illustrations of the shells of molluscos animals. Vol. 15, *Cerithium*, 20 pls. + index.
- Stewart, R. B. 1926. Gabb's California fossil type gastropods. Proc. Acad. Nat. Sci. Phila. 78: 287-477, pls. 20-32.
- Strausz, L. 1966. Die Miozän-Mediterranen Gastropoden Ungarns. Akademiai Kiadó, Budapest. 535 p., 79 pls.
- Sunderbrink, O. 1929. Zur Frage der Verwandtschaft zwischen Melaniiden und Cerithiiden. Z. Morph. Oikol. Tiere. 14: 216-337.
- Swainson, W. 1840. A Treatise on Malacology. London. 419 p.
- Tomlin, J. R. le B. and L. J. Shackelford. 1914. The marine mollusca of São Thome I. Jour. of Conch. 14: 239-276.
- Tryon, G. W. 1887. Manual of Conchology; structural and systematic; with illustrations of the species. First series; 9: *Cerithium*, p. 127-149, pls. 20-29.
- Valenciennes, A. 1832. Coquilles. [in] Humboldt, A. von and Bonpland. Voyage aux régions équinoxiales du Nouveau Continent . . . Pt. 2, 2: 217-339, pls. 48-50; 53-57.
- Vignal, L. 1902. Descriptions de cerithidés nouveaux. Journ. de Conchyliol. 49(4): 303-305, pl. 8.
- Vignal, L. 1910. Cerithiidae du Tertiaire Supérieur du Département de la Gironde. Journ. de Conchyliol. 58: 138-140.
- Warmke, G. L. and R. T. Abbott. 1961. Caribbean Seashells. Narberth, Penna., 346 p., 44 pls.
- Webb, W. 1942. United States Mollusca, St. Petersburg, Florida. 224 p., 67 pls.
- Weisbord, N. E. 1962. Late Cenozoic gastropods from northern Venezuela. Bull. Amer. Paleont. 42(193): 7-672, 48 pls.
- Wilson, B. R. and K. Gillett. 1972. Australian Shells. Rutland, Vermont. 168 p.
- Wood, E. 1910. The phylogeny of certain Cerithiidae. Ann. N. Y. Acad. Sci. 22(1), pt. 1: 1-92.
- Wood, W. 1828. Supplement to the Index Testaceologicus; or a catalogue of shells, British and foreign. London. p. 1-vi, 1-59, pls. 1-8.
- Woodard, T. M. 1934. Anatomy of the reproductive system of *Goniobasis laqueata* (Say). J. Tenn. Acad. Sci. 9(4): 243-259.
- Woodring, W. 1928. Miocene mollusks from Bowden, Jamaica. Pt. 2, Gastropods and discussion of results. Carnegie Inst. Wash. 564 p.
- Woodring, W. 1959. Geology and Paleontology of the Canal Zone. U. S. Geol. Surv. Prof. Pap. 306-B: 147-239, pls. 24-38.
- Zilch, A. 1958. Die Typen und Typoide des Natur-Museums Senkenberg. Arch. Moll. 87(1-3): 53.